INSTALLATION AND OPERATION MANUAL

# IPmux-2L

## TDM Pseudowire Access Gateway

Version 1.0

TDMoIP Driven®

RAD data communications

The Access Company

# IPmux-2L

TDM Pseudowire Access Gateway

Version 1.0

Installation and Operation Manual

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# Limited Warranty

RAD warrants to DISTRIBUTOR that the hardware in the IPmux-2L to be delivered hereunder shall be free of defects in material and workmanship under normal use and service for a period of twelve (12) months following the date of shipment to DISTRIBUTOR.

If, during the warranty period, any component part of the equipment becomes defective by reason of material or workmanship, and DISTRIBUTOR immediately notifies RAD of such defect, RAD shall have the option to choose the appropriate corrective action: a) supply a replacement part, or b) request return of equipment to its plant for repair, or c) perform necessary repair at the equipment's location. In the event that RAD requests the return of equipment, each party shall pay one-way shipping costs.

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This Agreement shall be construed and governed in accordance with the laws of the State of Israel.

# Product Disposal

To facilitate the reuse, recycling and other forms of recovery of waste equipment in protecting the environment, the owner of this RAD product is required to refrain from disposing of this product as unsorted municipal waste at the end of its life cycle. Upon termination of the unit's use, customers should provide for its collection for reuse, recycling or other form of environmentally conscientious disposal.

# General Safety Instructions

The following instructions serve as a general guide for the safe installation and operation of telecommunications products. Additional instructions, if applicable, are included inside the manual.

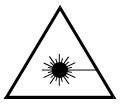
# Safety Symbols

***Warning***

This symbol may appear on the equipment or in the text. It indicates potential safety hazards regarding product operation or maintenance to operator or service personnel.

Danger of electric shock! Avoid any contact with the marked surface while the product is energized or connected to outdoor telecommunication lines.

Protective ground: the marked lug or terminal should be connected to the building protective ground bus.



***Warning***

Some products may be equipped with a laser diode. In such cases, a label with the laser class and other warnings as applicable will be attached near the optical transmitter. The laser warning symbol may be also attached.

Please observe the following precautions:

- Before turning on the equipment, make sure that the fiber optic cable is intact and is connected to the transmitter.
- Do not attempt to adjust the laser drive current.
- Do not use broken or unterminated fiber-optic cables/connectors or look straight at the laser beam.
- The use of optical devices with the equipment will increase eye hazard.
- Use of controls, adjustments or performing procedures other than those specified herein, may result in hazardous radiation exposure.

ATTENTION: The laser beam may be invisible!

In some cases, the users may insert their own SFP laser transceivers into the product. Users are alerted that RAD cannot be held responsible for any damage that may result if non-compliant transceivers are used. In particular, users are warned to use only agency approved products that comply with the local laser safety regulations for Class 1 laser products.

Always observe standard safety precautions during installation, operation and maintenance of this product. Only qualified and authorized service personnel should carry out adjustment, maintenance or repairs to this product. No installation, adjustment, maintenance or repairs should be performed by either the operator or the user.

# Handling Energized Products

## General Safety Practices

Do not touch or tamper with the power supply when the power cord is connected. Line voltages may be present inside certain products even when the power switch (if installed) is in the OFF position or a fuse is blown. For DC-powered products, although the voltages levels are usually not hazardous, energy hazards may still exist.

Before working on equipment connected to power lines or telecommunication lines, remove jewelry or any other metallic object that may come into contact with energized parts.

Unless otherwise specified, all products are intended to be grounded during normal use. Grounding is provided by connecting the mains plug to a wall socket with a protective ground terminal. If a ground lug is provided on the product, it should be connected to the protective ground at all times, by a wire with a diameter of 18 AWG or wider. Rack-mounted equipment should be mounted only in grounded racks and cabinets.

Always make the ground connection first and disconnect it last. Do not connect telecommunication cables to ungrounded equipment. Make sure that all other cables are disconnected before disconnecting the ground.

Some products may have panels secured by thumbscrews with a slotted head. These panels may cover hazardous circuits or parts, such as power supplies. These thumbscrews should therefore always be tightened securely with a screwdriver after both initial installation and subsequent access to the panels.

## Connecting AC Mains

Make sure that the electrical installation complies with local codes.

Always connect the AC plug to a wall socket with a protective ground.

The maximum permissible current capability of the branch distribution circuit that supplies power to the product is 16A (20A for USA and Canada). The circuit breaker in the building installation should have high breaking capacity and must operate at short-circuit current exceeding 35A (40A for USA and Canada).

Always connect the power cord first to the equipment and then to the wall socket. If a power switch is provided in the equipment, set it to the OFF position. If the power cord cannot be readily disconnected in case of emergency, make sure that a readily accessible circuit breaker or emergency switch is installed in the building installation.

In cases when the power distribution system is IT type, the switch must disconnect both poles simultaneously.

## Connecting DC Power

Unless otherwise specified in the manual, the DC input to the equipment is floating in reference to the ground. Any single pole can be externally grounded.

Due to the high current capability of DC power systems, care should be taken when connecting the DC supply to avoid short-circuits and fire hazards.

Make sure that the DC power supply is electrically isolated from any AC source and that the installation complies with the local codes.

The maximum permissible current capability of the branch distribution circuit that supplies power to the product is 16A (20A for USA and Canada). The circuit breaker in the building installation should have high breaking capacity and must operate at short-circuit current exceeding 35A (40A for USA and Canada).

Before connecting the DC supply wires, ensure that power is removed from the DC circuit. Locate the circuit breaker of the panel board that services the equipment and switch it to the OFF position. When connecting the DC supply wires, first connect the ground wire to the corresponding terminal, then the positive pole and last the negative pole. Switch the circuit breaker back to the ON position.

A readily accessible disconnect device that is suitably rated and approved should be incorporated in the building installation.

If the DC power supply is floating, the switch must disconnect both poles simultaneously.

# Connecting Data and Telecommunications Cables

Data and telecommunication interfaces are classified according to their safety status.

The following table lists the status of several standard interfaces. If the status of a given port differs from the standard one, a notice will be given in the manual.

| Ports | Safety Status | |
|---|---|---|
| V.11, V.28, V.35, V.36, RS-530, X.21, 10 BaseT, 100 BaseT, Unbalanced E1, E2, E3, STM, DS-2, DS-3, S-Interface ISDN, Analog voice E&M | SELV | Safety Extra Low Voltage:<br>Ports which do not present a safety hazard. Usually up to 30 VAC or 60 VDC. |
| xDSL (without feeding voltage), Balanced E1, T1, Sub E1/T1 | TNV-1 | Telecommunication Network Voltage-1:<br>Ports whose normal operating voltage is within the limits of SELV, on which overvoltages from telecommunications networks are possible. |
| FXS (Foreign Exchange Subscriber) | TNV-2 | Telecommunication Network Voltage-2:<br>Ports whose normal operating voltage exceeds the limits of SELV (usually up to 120 VDC or telephone ringing voltages), on which overvoltages from telecommunication networks are not possible. These ports are not permitted to be directly connected to external telephone and data lines. |
| FXO (Foreign Exchange Office), xDSL (with feeding voltage), U-Interface ISDN | TNV-3 | Telecommunication Network Voltage-3:<br>Ports whose normal operating voltage exceeds the limits of SELV (usually up to 120 VDC or telephone ringing voltages), on which overvoltages from telecommunication networks are possible. |

**Always connect a given port to a port of the same safety status. If in doubt, seek the assistance of a qualified safety engineer.**

Always make sure that the equipment is grounded before connecting telecommunication cables. Do not disconnect the ground connection before disconnecting all telecommunications cables.

Some SELV and non-SELV circuits use the same connectors. Use caution when connecting cables. Extra caution should be exercised during thunderstorms.

When using shielded or coaxial cables, verify that there is a good ground connection at both ends. The grounding and bonding of the ground connections should comply with the local codes.

The telecommunication wiring in the building may be damaged or present a fire hazard in case of contact between exposed external wires and the AC power lines. In order to reduce the risk, there are restrictions on the diameter of wires in the telecom cables, between the equipment and the mating connectors.

***Caution*** To reduce the risk of fire, use only No. 26 AWG or larger telecommunication line cords.

***Attention*** Pour réduire les risques s'incendie, utiliser seulement des conducteurs de télécommunications 26 AWG ou de section supérieure.

Some ports are suitable for connection to intra-building or non-exposed wiring or cabling only. In such cases, a notice will be given in the installation instructions.

Do not attempt to tamper with any carrier-provided equipment or connection hardware.

# Electromagnetic Compatibility (EMC)

The equipment is designed and approved to comply with the electromagnetic regulations of major regulatory bodies. The following instructions may enhance the performance of the equipment and will provide better protection against excessive emission and better immunity against disturbances.

A good ground connection is essential. When installing the equipment in a rack, make sure to remove all traces of paint from the mounting points. Use suitable lock-washers and torque. If an external grounding lug is provided, connect it to the ground bus using braided wire as short as possible.

The equipment is designed to comply with EMC requirements when connecting it with unshielded twisted pair (UTP) cables. However, the use of shielded wires is always recommended, especially for high-rate data. In some cases, when unshielded wires are used, ferrite cores should be installed on certain cables. In such cases, special instructions are provided in the manual.

Disconnect all wires which are not in permanent use, such as cables used for one-time configuration.

The compliance of the equipment with the regulations for conducted emission on the data lines is dependent on the cable quality. The emission is tested for UTP with 80 dB longitudinal conversion loss (LCL).

Unless otherwise specified or described in the manual, TNV-1 and TNV-3 ports provide secondary protection against surges on the data lines. Primary protectors should be provided in the building installation.

The equipment is designed to provide adequate protection against electro-static discharge (ESD). However, it is good working practice to use caution when connecting cables terminated with plastic connectors (without a grounded metal hood, such as flat cables) to sensitive data lines. Before connecting such cables, discharge yourself by touching ground or wear an ESD preventive wrist strap.

# FCC-15 User Information

This equipment has been tested and found to comply with the limits of the Class A digital device, pursuant to Part 15 of the FCC rules. These limits are designed to provide reasonable protection against harmful interference when the equipment is operated in a commercial environment. This equipment generates, uses and can radiate radio frequency energy and, if not installed and used in accordance with the Installation and Operation manual, may cause harmful interference to the radio communications. Operation of this equipment in a residential area is likely to cause harmful interference in which case the user will be required to correct the interference at his own expense.

# Canadian Emission Requirements

This Class A digital apparatus meets all the requirements of the Canadian Interference-Causing Equipment Regulation.

Cet appareil numérique de la classe A respecte toutes les exigences du Règlement sur le matériel brouilleur du Canada.

# Warning per EN 55022 (CISPR-22)

| | |
|---|---|
| ***Warning*** | This is a class A product. In a domestic environment, this product may cause radio interference, in which case the user will be required to take adequate measures. |
| ***Avertissement*** | Cet appareil est un appareil de Classe A. Dans un environnement résidentiel, cet appareil peut provoquer des brouillages radioélectriques. Dans ces cas, il peut être demandé à l'utilisateur de prendre les mesures appropriées. |
| ***Achtung*** | Das vorliegende Gerät fällt unter die Funkstörgrenzwertklasse A. In Wohngebieten können beim Betrieb dieses Gerätes Rundfunkströrungen auftreten, für deren Behebung der Benutzer verantwortlich ist. |

# Mise au rebut du produit

Afin de faciliter la réutilisation, le recyclage ainsi que d'autres formes de récupération d'équipement mis au rebut dans le cadre de la protection de l'environnement, il est demandé au propriétaire de ce produit RAD de ne pas mettre ce dernier au rebut en tant que déchet municipal non trié, une fois que le produit est arrivé en fin de cycle de vie. Le client devrait proposer des solutions de réutilisation, de recyclage ou toute autre forme de mise au rebut de cette unité dans un esprit de protection de l'environnement, lorsqu'il aura fini de l'utiliser.

# Instructions générales de sécurité

Les instructions suivantes servent de guide général d'installation et d'opération sécurisées des produits de télécommunications. Des instructions supplémentaires sont éventuellement indiquées dans le manuel.

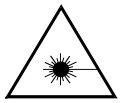
# Symboles de sécurité

***Avertissement***

Ce symbole peut apparaitre sur l'équipement ou dans le texte. Il indique des risques potentiels de sécurité pour l'opérateur ou le personnel de service, quant à l'opération du produit ou à sa maintenance.

Danger de choc électrique ! Evitez tout contact avec la surface marquée tant que le produit est sous tension ou connecté à des lignes externes de télécommunications.

Mise à la terre de protection : la cosse ou la borne marquée devrait être connectée à la prise de terre de protection du bâtiment.



***Avertissement***

Certains produits peuvent être équipés d'une diode laser. Dans de tels cas, une étiquette indiquant la classe laser ainsi que d'autres avertissements, le cas échéant, sera jointe près du transmetteur optique. Le symbole d'avertissement laser peut aussi être joint.

Veuillez observer les précautions suivantes :

- Avant la mise en marche de l'équipement, assurez-vous que le câble de fibre optique est intact et qu'il est connecté au transmetteur.
- Ne tentez pas d'ajuster le courant de la commande laser.
- N'utilisez pas des câbles ou connecteurs de fibre optique cassés ou sans terminaison et n'observez pas directement un rayon laser.
- L'usage de périphériques optiques avec l'équipement augmentera le risque pour les yeux.
- L'usage de contrôles, ajustages ou procédures autres que celles spécifiées ici pourrait résulter en une dangereuse exposition aux radiations.

ATTENTION : Le rayon laser peut être invisible !

Les utilisateurs pourront, dans certains cas, insérer leurs propres émetteurs-récepteurs Laser SFP dans le produit. Les utilisateurs sont avertis que RAD ne pourra pas être tenue responsable de tout dommage pouvant résulter de l'utilisation d'émetteurs-récepteurs non conformes. Plus particulièrement, les utilisateurs sont avertis de n'utiliser que des produits approuvés par l'agence et conformes à la réglementation locale de sécurité laser pour les produits laser de classe 1.

Respectez toujours les précautions standards de sécurité durant l'installation, l'opération et la maintenance de ce produit. Seul le personnel de service qualifié et autorisé devrait effectuer l'ajustage, la maintenance ou les réparations de ce produit. Aucune opération d'installation, d'ajustage, de maintenance ou de réparation ne devrait être effectuée par l'opérateur ou l'utilisateur.

# Manipuler des produits sous tension

## Règles générales de sécurité

Ne pas toucher ou altérer l'alimentation en courant lorsque le câble d'alimentation est branché. Des tensions de lignes peuvent être présentes dans certains produits, même lorsque le commutateur (s'il est installé) est en position OFF ou si le fusible est rompu. Pour les produits alimentés par CC, les niveaux de tension ne sont généralement pas dangereux mais des risques de courant peuvent toujours exister.

Avant de travailler sur un équipement connecté aux lignes de tension ou de télécommunications, retirez vos bijoux ou tout autre objet métallique pouvant venir en contact avec les pièces sous tension.

Sauf s'il en est autrement indiqué, tous les produits sont destinés à être mis à la terre durant l'usage normal. La mise à la terre est fournie par la connexion de la fiche principale à une prise murale équipée d'une borne protectrice de mise à la terre. Si une cosse de mise à la terre est fournie avec le produit, elle devrait être connectée à tout moment à une mise à la terre de protection par un conducteur de diamètre 18 AWG ou plus. L'équipement monté en châssis ne devrait être monté que sur des châssis et dans des armoires mises à la terre.

Branchez toujours la mise à la terre en premier et débranchez-la en dernier. Ne branchez pas des câbles de télécommunications à un équipement qui n'est pas mis à la terre. Assurez-vous que tous les autres câbles sont débranchés avant de déconnecter la mise à la terre.

## Connexion au courant du secteur

Assurez-vous que l'installation électrique est conforme à la réglementation locale.

Branchez toujours la fiche de secteur à une prise murale équipée d'une borne protectrice de mise à la terre.

La capacité maximale permissible en courant du circuit de distribution de la connexion alimentant le produit est de 16A (20A aux Etats-Unis et Canada). Le coupe-circuit dans l'installation du bâtiment devrait avoir une capacité élevée de rupture et devrait fonctionner sur courant de court-circuit dépassant 35A (40A aux Etats-Unis et Canada).

Branchez toujours le câble d'alimentation en premier à l'équipement puis à la prise murale. Si un commutateur est fourni avec l'équipement, fixez-le en position OFF. Si le câble d'alimentation ne peut pas être facilement débranché en cas d'urgence, assurez-vous qu'un coupe-circuit ou un disjoncteur d'urgence facilement accessible est installé dans l'installation du bâtiment.

Le disjoncteur devrait déconnecter simultanément les deux pôles si le système de distribution de courant est de type IT.

## Connexion d'alimentation CC

Sauf s'il en est autrement spécifié dans le manuel, l'entrée CC de l'équipement est flottante par rapport à la mise à la terre. Tout pôle doit être mis à la terre en externe.

A cause de la capacité de courant des systèmes à alimentation CC, des précautions devraient être prises lors de la connexion de l'alimentation CC pour éviter des courts-circuits et des risques d'incendie.

Assurez-vous que l'alimentation CC est isolée de toute source de courant CA (secteur) et que l'installation est conforme à la réglementation locale.

La capacité maximale permissible en courant du circuit de distribution de la connexion alimentant le produit est de 16A (20A aux Etats-Unis et Canada). Le coupe-circuit dans l'installation du bâtiment devrait avoir une capacité élevée de rupture et devrait fonctionner sur courant de court-circuit dépassant 35A (40A aux Etats-Unis et Canada).

Avant la connexion des câbles d'alimentation en courant CC, assurez-vous que le circuit CC n'est pas sous tension. Localisez le coupe-circuit dans le tableau desservant l'équipement et fixez-le en position OFF. Lors de la connexion de câbles d'alimentation CC, connectez d'abord le conducteur de mise à la terre à la borne correspondante, puis le pôle positif et en dernier, le pôle négatif. Remettez le coupe-circuit en position ON.

Un disjoncteur facilement accessible, adapté et approuvé devrait être intégré à l'installation du bâtiment.

Le disjoncteur devrait déconnecter simultanément les deux pôles si l'alimentation en courant CC est flottante.

# Declaration of Conformity

| | |
|---|---|
| **Manufacturer's Name:** | RAD Data Communications Ltd. |
| **Manufacturer's Address:** | 24 Raoul Wallenberg St., Tel Aviv 69719, Israel |

declares that the product:

| | |
|---|---|
| **Product Name:** | IPmux-2L |

conforms to the following standard(s) or other normative document(s):

| | | |
|---|---|---|
| **EMC:** | EN 55022: 2006 | Information technology equipment – Radio disturbance characteristics – Limits and methods of measurement. |
| | EN 50024: 1998+ A1:2001, A2:2003 | Information technology equipment – Immunity characteristics – Limits and methods of measurement. |
| | EN 61000-3-2:2006 | Electromagnetic compatibility (EMC) - Part 3-2: Limits - Limits for harmonic current emissions (equipment input current ≤16A per phase) |
| | EN 61000-3-3:1995 + A1:2001, A2:2005 | Electromagnetic compatibility (EMC) - Part 3-3: Limits - Limitation of voltage changes, voltage fluctuations and flicker in public low-voltage supply systems, for equipment with rated current ≤ 16A per phase and not subject to conditional connection. |
| **Safety:** | EN 60950-1:2001 + A11:2004 | Information technology equipment – Safety – Part 1: General requirements. |

**Supplementary Information:**

The product herewith complies with the requirements of the EMC Directive 2004/108/EC, the Low Voltage Directive 2006/95/EC and the R&TTE Directive 99/5/EC for wired equipment. The product was tested in a typical configuration.

Tel Aviv, 23 December, 2008

Haim Karshen

VP Quality

**European Contact:** RAD Data Communications GmbH, Otto-Hahn-Str. 28-30, 85521 Ottobrunn-Riemerling, Germany

# Glossary

| | |
|---|---|
| Address | A coded representation of the origin or destination of data. |
| Attenuation | Signal power loss through equipment, lines or other transmission devices. Measured in decibels. |
| AWG | The American Wire Gauge System, which specifies wire width. |
| Balanced | A transmission line in which voltages on the two conductors are equal in magnitude, but opposite in polarity, with respect to ground. |
| Bandwidth | The range of frequencies passing through a given circuit. The greater the bandwidth, the more information can be sent through the circuit in a given amount of time. |
| Bipolar | Signaling method in E1/T1 representing a binary "1" by alternating positive and negative pulses, and a binary "0" by absence of pulses. |
| Bit | The smallest unit of information in a binary system. Represents either a one or zero ("1" or "0"). |
| Bridge | A device interconnecting local area networks at the OSI data link layer, filtering and forwarding frames according to media access control (MAC) addresses. |
| Buffer | A storage device. Commonly used to compensate for differences in data rates or event timing when transmitting from one device to another. Also used to remove jitter. |
| Byte | A group of bits (normally 8 bits in length). |
| Cell | The 53-byte basic information unit within an ATM network. The user traffic is segmented into cells at the source and reassembled at the destination. An ATM cell consists of a 5-byte ATM header and a 48-byte ATM payload, which contains the user data. |
| CESoPSN | Structure-aware TDM Circuit Emulation Service over Packet Switched Network. A method for encapsulating structured (NxDS0) Time Division Multiplexed (TDM) signals as pseudo-wires over packet switched networks (PSN). |
| Channel | A path for electrical transmission between two or more points. Also called a link, line, circuit or facility. |
| Circuit Emulation Service | Technology for offering circuit emulation services over packet-switched networks. The service offers traditional TDM trunking (at n x 64 kbps, fractional E1/T1, E1/T1 or E3/T3) over a range of transport protocols, including Internet Protocol (IP), MPLS and Ethernet. |
| Clock | A term for the source(s) of timing signals used in synchronous transmission. |

| | |
|---|---|
| Data | Information represented in digital form, including voice, text, facsimile and video. |
| Diagnostics | The detection and isolation of a malfunction or mistake in a communications device, network or system. |
| Encapsulation | Encapsulating data is a technique used by layered protocols in which a low level protocol accepts a message from a higher level protocol, then places it in the data portion of the lower-level frame. The logistics of encapsulation require that packets traveling over a physical network contain a sequence of headers. |
| Ethernet | A local area network (LAN) technology which has extended into the wide area networks. Ethernet operates at many speeds, including data rates of 10 Mbps (Ethernet), 100 Mbps (Fast Ethernet), 1,000 Mbps (Gigabit Ethernet), 10 Gbps, 40 Gbps, and 100 Gbps. |
| Flow Control | A congestion control mechanism that results in an ATM system implementing flow control. |
| Frame | A logical grouping of information sent as a link-layer unit over a transmission medium. The terms packet, datagram, segment, and message are also used to describe logical information groupings. |
| Framing | At the physical and data link layers of the OSI model, bits are fit into units called frames. Frames contain source and destination information, flags to designate the start and end of the frame, plus information about the integrity of the frame. All other information, such as network protocols and the actual payload of data, is encapsulated in a packet, which is encapsulated in the frame. |
| Full Duplex | A circuit or device permitting transmission in two directions (sending and receiving) at the same time. |
| G.703 | An ITU standard for the physical and electrical characteristics of various digital interfaces, including those at 64 kbps and 2.048 Mbps. |
| Gateway | Gateways are points of entrance and exit from a communications network. Viewed as a physical entity, a gateway is that node that translates between two otherwise incompatible networks or network segments. Gateways perform code and protocol conversion to facilitate traffic between data highways of differing architecture. |
| Impedance | The combined effect of resistance, inductance and capacitance on a transmitted signal. Impedance varies at different frequencies. |
| Interface | A shared boundary, defined by common physical interconnection characteristics, signal characteristics, and meanings of exchanged signals. |

| | |
|---|---|
| IP Address | Also known as an Internet address. A unique string of numbers that identifies a computer or device on a TCP/IP network. The format of an IP address is a 32-bit numeric address written as four numbers from 0 to 255, separated by periods (for example, 1.0.255.123). |
| Jitter | The deviation of a transmission signal in time or phase. It can introduce errors and loss of synchronization in high speed synchronous communications. |
| Loading | The addition of inductance to a line in order to minimize amplitude distortion. Used commonly on public telephone lines to improve voice quality, it can make the lines impassable to high speed data, and baseband modems. |
| Loopback | A type of diagnostic test in which the transmitted signal is returned to the sending device after passing through all or part of a communications link or network. |
| Manager | An application that receives Simple Network Management Protocol (SNMP) information from an agent. An agent and manager share a database of information, called the Management Information Base (MIB). An agent can use a message called a traps-PDU to send unsolicited information to the manager. A manager that uses the RADview MIB can query the RAD device, set parameters, sound alarms when certain conditions appear, and perform other administrative tasks. |
| Master Clock | The source of timing signals (or the signals themselves) that all network stations use for synchronization. |
| Network | (1) An interconnected group of nodes. (2) A series of points, nodes, or stations connected by communications channels; the collection of equipment through which connections are made between data stations. |
| Packet | An ordered group of data and control signals transmitted through a network, as a subset of a larger message. |
| Payload | The 48-byte segment of the ATM cell containing user data. Any adaptation of user data via the AAL will take place within the payload. |
| Physical Layer | Layer 1 of the OSI model. The layer concerned with electrical, mechanical, and handshaking procedures over the interface connecting a device to the transmission medium. |
| Port | The physical interface to a computer or multiplexer, for connection of terminals and modems. |
| Protocol | A formal set of conventions governing the formatting and relative timing of message exchange between two communicating systems. |

| | |
|---|---|
| **Pseudowire** | Point-to-point connections set up to emulate (typically Layer 2) native services like ATM, Frame Relay, Ethernet, TDM, or SONET/SDH over an underlying common packet-switched network (Ethernet, MPLS or IP) core. Pseudowires are defined by the IETF PWE3 (pseudowire emulation edge-to-edge) working group. |
| **SAToP** | Structure-Agnostic Time Division Multiplexing (TDM) over Packet. A method for encapsulating Time Division Multiplexing (TDM) bit-streams (T1, E1, T3, E3) that disregards any structure that may be imposed on these streams, in particular the structure imposed by the standard TDM framing. |
| **Space** | In telecommunications, the absence of a signal. Equivalent to a binary 0. |
| **T1** | A digital transmission link with a capacity of 1.544 Mbps used in North America. Typically channelized into 24 DS0s, each capable of carrying a single voice conversation or data stream. Uses two pairs of twisted pair wires. |
| **Throughput** | The amount of information transferred through the network between two users in a given period, usually measured in the number of packets per second (pps). |
| **TDMoIP®** | TDM over IP is a standards-based pseudowire transport technology that extends voice, video or data circuits across packet-switched networks simply, transparently and economically. TDMoIP supports the multiple signaling standards, OAM mechanisms and clock recovery features demanded by TDM networks for carrying voice-grade telephony. |

# Quick Start Guide

Installation of IPmux-2L should be carried out only by an experienced technician. If you are familiar with IPmux-2L, use this guide to prepare the unit for operation.

## 1. Installing IPmux-2L

### Connecting the Interfaces

1. Connect the network to the Ethernet port configured as a network port.
2. Connect the user LAN(s) to the Ethernet ports configured as a user port.
3. Connect the E1 lines to the RJ-45 or BNC connectors designated E1.
4. Connect the serial data equipment to the DB-25 or RJ-45 connector designated SERIAL. Use the appropriate adapter cable.

***Caution***

When connecting balanced E1 equipment, make sure to use only 4-wire RJ-45 connectors with the following pins used for receiving and transmitting data: 1, 2, 4, 5. Do not use 8-pin RJ-45 connectors.

5. Connect the control terminal to the rear panel CONTROL connector.

   or

   Connect a Telnet, or a PC running a Web browsing application to one of the ETH ports.

### Connecting the Power

- Connect the power cable to the power connector on the IPmux-2L rear panel.

  The unit has no power switch. Operation starts when the power is applied to the rear panel power connector.

## 2. Configuring IPmux-2L

Configure IPmux-2L to the desired operation mode via an ASCII terminal connected to the rear panel CONTROL port. Alternatively, you can manage IPmux-2L over Telnet, or via a PC running a Web browsing application connected to one of the ETH ports.

## Starting a Terminal Session for the First Time

➤ **To start a terminal session:**

1. Connect a terminal to the CONTROL connector of IPmux-2L.
2. Turn on the control terminal PC and set its port parameters to 115,200 baud, 8 bits/character, 1 stop bit, no parity. Set the terminal emulator to ANSI VT100 emulation (for optimal view of system menus).
3. Power IPmux-2L up and proceed with the management session.

## Configuring the Host IP Parameters

The host IP parameters consists of Management Host IP and Service Host IP, and each Host IP parameters including IP address, subnet mask, and default gateway IP address must be configured via an ASCII terminal.

➤ **To configure the management Host IP parameters:**

1. From the Host IP menu (**Main** › **Configuration** › **System** › **Host IP** › **Management Host IP**), Disable the DHCP.
2. From this menu, select an IP address of the IPmux-2L host.

➤ **To configure the Service Host IP parameters:**

- From the Host IP menu (**Main** › **Configuration** › **System** › **Host IP** › **Service Host IP**), select an IP address of the IPmux-2L host.

## Configuring E1 at the Physical Level

E1 interfaces must be configured at the physical level first.

➤ **To configure E1 at the physical level:**

- From the TDM Configuration menu (**Configuration** › **Physical layer** › **TDM**), configure the necessary parameters of the E1 services.

## Configuring Serial Interface at the Physical Level

If IPmux-2L includes a serial data interface then it must be configured at the physical layer.

➤ **To configure HS at the physical interface:**

- From the HS Configuration menu (**Configuration** › **Physical Layer** › **HS**), select the data speed and clock mode.

## Configuring Bundle Connections

The E1 timeslots must be assigned to a bundle. The bundle must be sent to the remote IP address and be connected to one of the destination bundles.

➤ **To assign timeslots to a bundle:**

- From the DS0 Bundle Configuration menu (**Main** › **Configuration** › **Connection** › **DS0 bundle configuration**), assign desired timeslots to a bundle by select or remove the timeslots.

➤ **To connect a bundle:**

1. From the Bundle Connection Configuration menu (**Main** › **Configuration** › **Connection** › **Bundle connection**), set the following:
   - Destination IP address
   - Destination bundle
   - Source bundle
2. From the Bundle Connection Configuration menu (**Main** › **Configuration** › **Connection** › **Bundle connection**), set Connection status as **Enable.**

## Configuring the Internal Bridge

➤ **To configure the Ethernet behaviors for the internal bridge ports:**

1. From the Ethernet Service Configuration menu (**Main** › **Configuration** › **Ethernet Service** › **bridge configuration**), do the following:
   - Specify VLAN mode (aware or unaware)
   - Specify forwarding mode (transparent or filter)
2. From the Bridge Port Configuration menu (**Main** › **Configuration** › **Ethernet Service** › **bridge configuration** › **Bridge port** ), do the following:
   - Specify port role (network port or user port)
   - Set VLAN tagging mode (Untag/Tag/Transparent/Double Tag) for each port
   - Set port VID for each port
   - Set default priority tag.
3. From the VLAN Membership port Configuration menu (**Main** › **Configuration** › **Ethernet Service** › **Bridge** › **VLAN Membership**), assign VLANs for each bridge port and Egress Tag behaviors for every VLAN, if necessary.

- From the QoS Configuration menu (**Main** › **Configuration** › **Ethernet Service** › **QoS)**, do the following:
  - Specify scheduler mode
  - Specify classification rules
  - Set the egress and ingress rate limit for each port.

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# Chapter 1
# Introduction

## 1.1 Overview

IPmux-2L offers a solution for extending traditional E1 services transparently over packet switched networks (PSNs) such as IP, Ethernet, and MPLS networks. The device converts the data stream coming from its one or two TDM ports or a high speed serial port into configurable-sized packets that are extended over the Fast Ethernet network port, and vice versa. IPmux-2L offers end-to-end synchronization for leased line applications. IPmux-2L also features two Fast Ethernet user ports for data (Ethernet) connectivity to the IP/Ethernet network. Management is performed locally by a terminal, or remotely via Telnet, Web terminal or SNMP.

### Device Options

IPmux-2L is available with the following TDM interface options:

- One E1 port or two E1 ports
- One serial data port.

### Applications

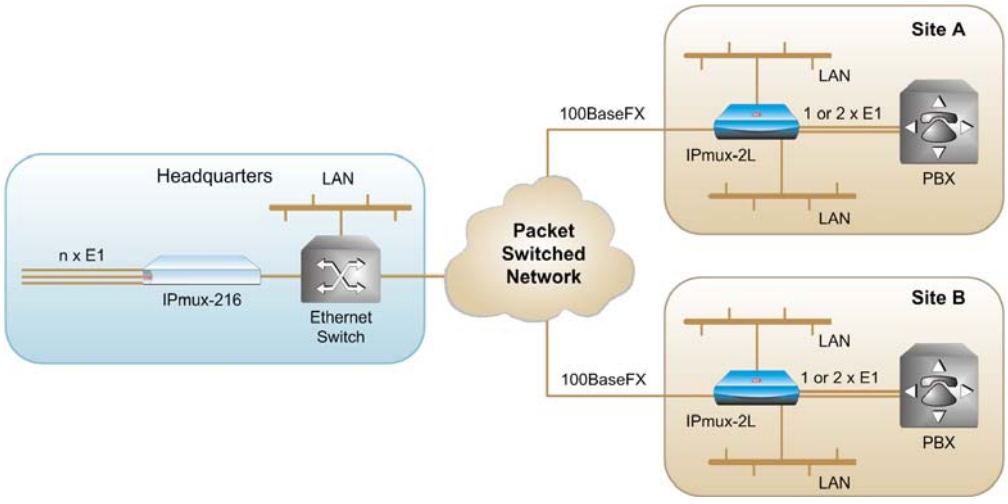


*Figure 1-1. Multiplexing Voice and Ethernet over a Packet Switched Network*

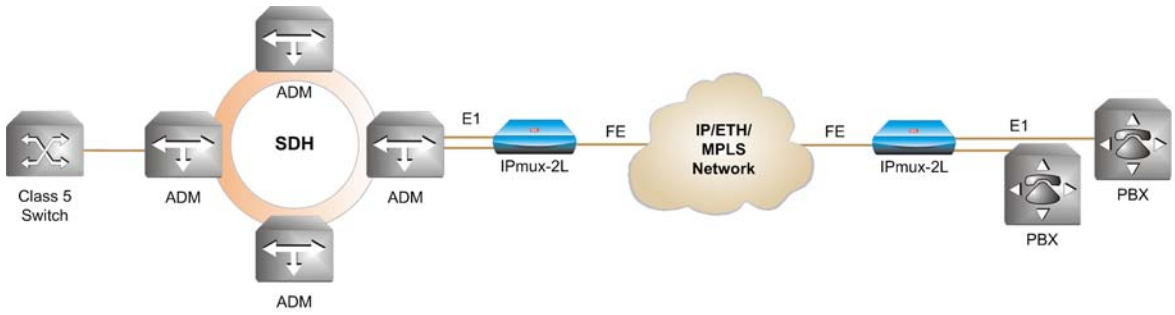


*Figure 1-2. Private and Leased Line over Packet*

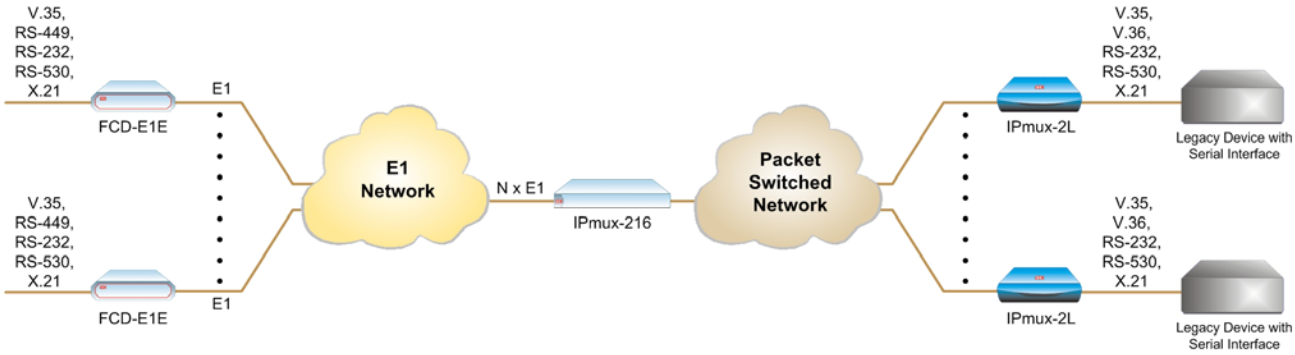


*Figure 1-3. Gradual Migration from Serial Data Services to a Packet-Switched Network*

# Features

## E1 Interface

The E1 ports comply with G.703, G.704, and G.823 standards. The E1 ports support unframed, framed, and multiframe operation with or without CRC-4. The E1 port supports long haul and short haul input signals and can be monitored for alarms and error statistics.

The E1 interface options are:

- 120Ω balanced line interface terminating in an eight-pin RJ-45 (ISO 10173) connector
- 75Ω unbalanced interface terminating in two BNC coaxial connectors.

## Serial Data Interface

The IPmux-2L serial data interface can be ordered with one V.35 interface, or one of the following types of interface: RS-530/RS-422,V.24/RS-232, V.36/RS-449 and X.21. The data port is terminated in a 25-pin D-type female connector.

The conversion between the 25-pin channel interface connector and the standard V.35, X.21 or V.36/RS-449 interface connector is made via adapter cables:

- V.36/RS-449 interface: the adapter cable is terminated in a 37-pin D-type female connector
- V.35 interface: the adapter cable is terminated in a 34-pin female connector
- X.21 interface: the adapter cable is terminated in a 15-pin D-type female connector.

Suitable adapter cables can be ordered from RAD.

DCE/DTE port configuration is performed via adapter cables and the IPmux-2L clock selection.

## Ethernet Interface

IPmux-2L is available with three Ethernet ports (each port can be a user, network, or management interface). The Ethernet ports include one fiber port and two UTP ports:

- Fiber – standard 100BaseFx full-duplex port. This port accepts a wide range of SFP transceivers offered by RAD. See the SFP Transceivers data sheet for details.
- UTP – standard 10/100BaseT half/full-duplex ports with autonegotiation and automatic crossover support.

### IP

The data stream coming from the E1 port is converted into IP packets that are transported over the Ethernet ports, and vice versa. TDM bytes are encapsulated in a UDP frame that runs over IP and over Ethernet. The number of TDM bytes in an IP frame is configurable for throughput/delay tradeoff.

Each device can have a single IP (identical service IP/management IP) or dual IP (different service IP and management IP). A configurable destination IP address is assigned to the IP packets.

### MPLS

IPmux-2L encapsulates TDM data with MPLS labels for transporting it over MPLS networks (TDMoMPLS). Saving up to 20 bytes of overhead in comparison to the standard TDMoIP encapsulation, TDMoMPLS is ideal for bandwidth-sensitive networks.

## TDM Service Operation Modes

- Unframed E1 over UDP over IP over Ethernet
- Fractional E1 over UDP over IP over Ethernet
- Fractional E1 with CAS over UDP over IP over Ethernet.

## QoS

QoS supports:

- Labeling IP level priority (ToS/Diffserv) for TDMoIP packets
- VLAN tagging and priority labeling according to IEEE 802.1p&Q for TDMoIP packets
- Using EXP bits for QoS marking of the TDMoIP traffic in MPLS networks.

The user can configure the ToS (Type of Service) of the outgoing TDMoIP packets. This allows an en-route Layer 3 router or switch, which supports ToS, to give higher priority to IPmux-2L TDMoIP traffic for delay-sensitive and secure applications. IPmux-2L allows you to configure the whole ToS byte field, since

different vendors may use different bits to tag packets for traffic prioritization. This also enables operation according to various RFC definitions (for example RFC 2474, RFC 791). The user can also configure VLAN priority bits for Level 2 priority.

### Management

IPmux-2L can be managed locally by connecting an ASCII terminal to the RS-232 port on the rear panel, or via Telnet, Web or SNMP.

### Timing

IPmux-2L maintains synchronization between TDM devices by deploying advanced clock distribution mechanisms. Available timing modes are:

- Loopback
- Adaptive
- Internal clock
- External clock.

## 1.2 Physical Description

IPmux-2L is a compact, easy-to-install standalone unit. *Figure 1-4* shows a typical unit.

*Figure 1-4. IPmux-2L 3D View*

The front panel includes the IPmux-2L LEDs. For the detailed LED description, see *Chapter 3*.

Ethernet, E1, serial and management ports, and the power supply connector are located on the rear panel of unit. For further details, see *Chapter 2*.

## 1.3 Functional Description

IPmux-2L provides TDM connectivity across the IP/Ethernet network. A single bundle (group of timeslots) can be transmitted to a predefined far-end bundle.

The unit includes one or two E1 ports or a HS port. Traffic is transmitted over the network as E1 or fractional E1, using the TDMoIP or TDMoMPLS method. It also supports two Ethernet user ports for user LAN connectivity.

Configuration and management are provided via the IPmux-2L local terminal, or remotely via Web, Telnet or SNMP (RADview-EMS).

## Operation Modes

This section describes the IPmux-2L operation modes, which are:

- Unframed E1
- Fractional E1
- Fractional E1 with CAS.

### Unframed

In the unframed mode, the incoming bit stream from each channel (regardless of framing) is converted into IP over Ethernet frames. This option provides clear channel end-to-end service (unframed).

### Fractional

In the fractional mode, the incoming bit stream is regarded as a sequence of n × 64 kbps timeslots (according to framing). Each predefined group of timeslots is converted into a structure block. The structure block is packetized into IP frames and transmitted.

This mode allows transmission of several selected timeslots without the whole E1 frame, as in transparent mode.

### Fractional with CAS

In the fractional-with-CAS mode, the structure block (as described under Fractional Operation Modes, above) also includes Channel Associated Signaling (CAS) from timeslot 16 (E1). The relevant portion of the signaling channel is packetized and sent to the destination.

## Timeslot Assignment in a Bundle

A bundle is a group of timeslots associated with a specific E1 channel. IPmux-2L places individual or multiple TDM timeslots (up to 31 timeslots) into bundles with a single IP address destination. IPmux-2L supports up to 63 bundles (31 bundles per E1, and 1 bundle per serial data port).

## Testing Diagnostic

Diagnostic capabilities include E1 local/remote loopback tests and internal/external BERT for rapid localization of faults. The E1 traffic can be looped locally, toward the line, or toward the remote end, and the E1 link BER performance test can be performed locally, toward the E1 line or the remote end (See *Chapter 6* for more information).

## Timing Modes

IPmux-2L supports different timing modes to provide maximum flexibility for connecting the IPmux-2L E1 ports.

Each of the clocks must be configured correctly on both the receive and transmit ends to ensure proper operation and prevent pattern slips (see *Figure 1-5*, *Figure 1-6* and *Figure 1-7*).

### E1 Timing

Synchronization between TDM devices is maintained by deploying advanced clock distribution mechanisms. The clocking options are:

- Loopback timing – the E1 Tx clock is derived from the E1 receive (Rx) clock.
- Adaptive timing – in this mode, the E1 Tx clock is regenerated using the adaptive method. In this method, the fill level of the buffer receiving packets is monitored. If the buffer begins to overfill, the regenerated Tx clock frequency increases to avoid overflow. If the buffer begins to empty, the Tx clock frequency (toward the TDM device) decreases to avoid underflow.
- Internal timing – in this mode, the Tx clock is derived from an internal oscillator.
- External timing –in this mode the Tx clock is derived from the E1 ports which is connected to external source clock.

***Note*** *In adaptive timing, the regenerated clock is subject to network packet delay variation. That is why the quality of the adaptive clock depends on the quality of the network.*

### Serial Data Port Timing

The IPmux-2L data port has three timing modes:

- **DCE** – the IPmux-2L data port provides transmit and receive clock, derived from the system clock, internal clock or adaptive clock, for the user's equipment connected to the data port.
- **DTE1** – the IPmux-2L data port sends the receive data accompanied by the receive clock, derived from the system clock, internal clock or adaptive clock, to the user's equipment connected to the data port, and accepts user's data according to the user's equipment transmit clock. The DTE1 mode is not available for the channels with X.21 interface.
- **DTE2** – IPmux-2L transmits and receives data according to the clock signals provided by the equipment connected to the data port. The DTE2 mode is not available for the channels with X.21 interface.

### System Timing

The IPmux-2L TDM links can be configured to use system clock, synchronized to internal, loopback, external or adaptive timing sources. The system clock has master and fallback sources. If a fallback clock source fails, IPmux-2L switches to internal timing.

## Network Timing Schemes

The following paragraphs describe typical timing schemes and the correct timing mode settings for achieving end-to-end synchronization.

### External Network Timing

When the edges of the network are synchronized by an external network clock source, all the IPmux-2L units should be configured to work in loopback timing mode (see *Figure 1-5*). This topology enables any-to-any connectivity.

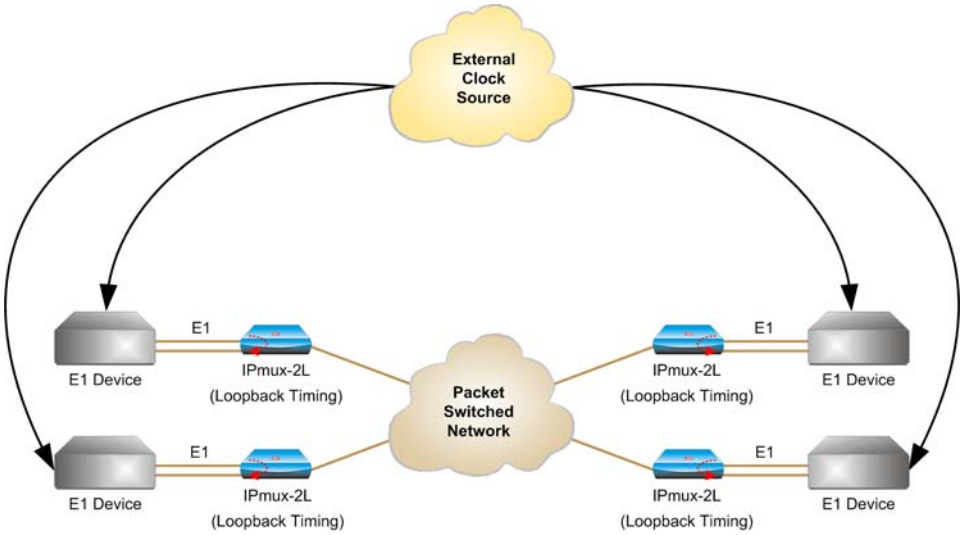


*Figure 1-5. IPmux-2L in Loopback Timing Mode*

External timing from the network can also be issued to IPmux-2L by one of the E1 ports.

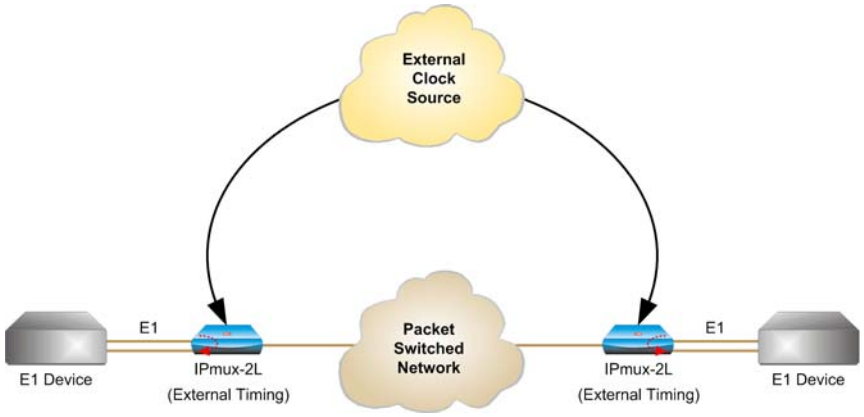


*Figure 1-6. IPmux-2L in External Clock Mode*

### Single Source Clock Network

When a common clock is not available on all the ends of the network, one of the IPmux-2L devices is configured to work in loopback timing, while the other IPmux-2L device is configured to work in adaptive timing (see *Figure 1-7*).

*Figure 1-7. IPmux-2L in Adaptive Timing Mode*

## Payload Encapsulation

IPmux-2L supports the following payload encapsulation techniques:

- TDMoIP
- CESoPSN
- SAToP
- HDLC.

### CESoPSN

The CESoPSN (Circuit Emulation Service over PSN) is a structure-aware format for framed E1 services (with or without CAS). It converts structured E1 data flows into IP or MPLS packets and vice versa with static assignment of timeslots inside a bundle according to ITU-T Y.1413 and IETF RFC 5086.

The CESoPSN without CAS packet size is a multiple of TDM frame size.

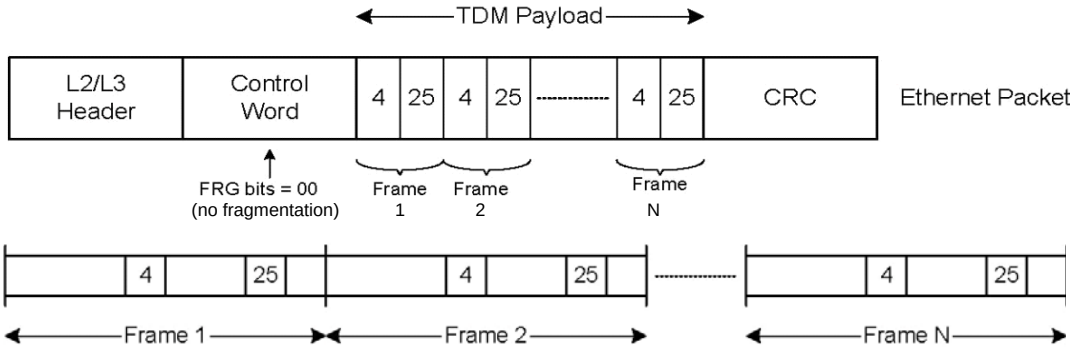


*Figure 1-8. CESoPSN without CAS Encapsulation (E1, Bundle with Timeslots 4 and 25)*

The CESoPSN with CAS (with Fragmentation) packet size is divided into several packets, each packet contains a multiple of TDM frames blocks (also called M TDM blocks), and the last packet contains M TDM blocks followed by the entire multiframe CAS information. The M can be 1, 2, 4, 8, or 16. When M equals 16, CESoPSN is considered to be with CAS (without fragmentation).

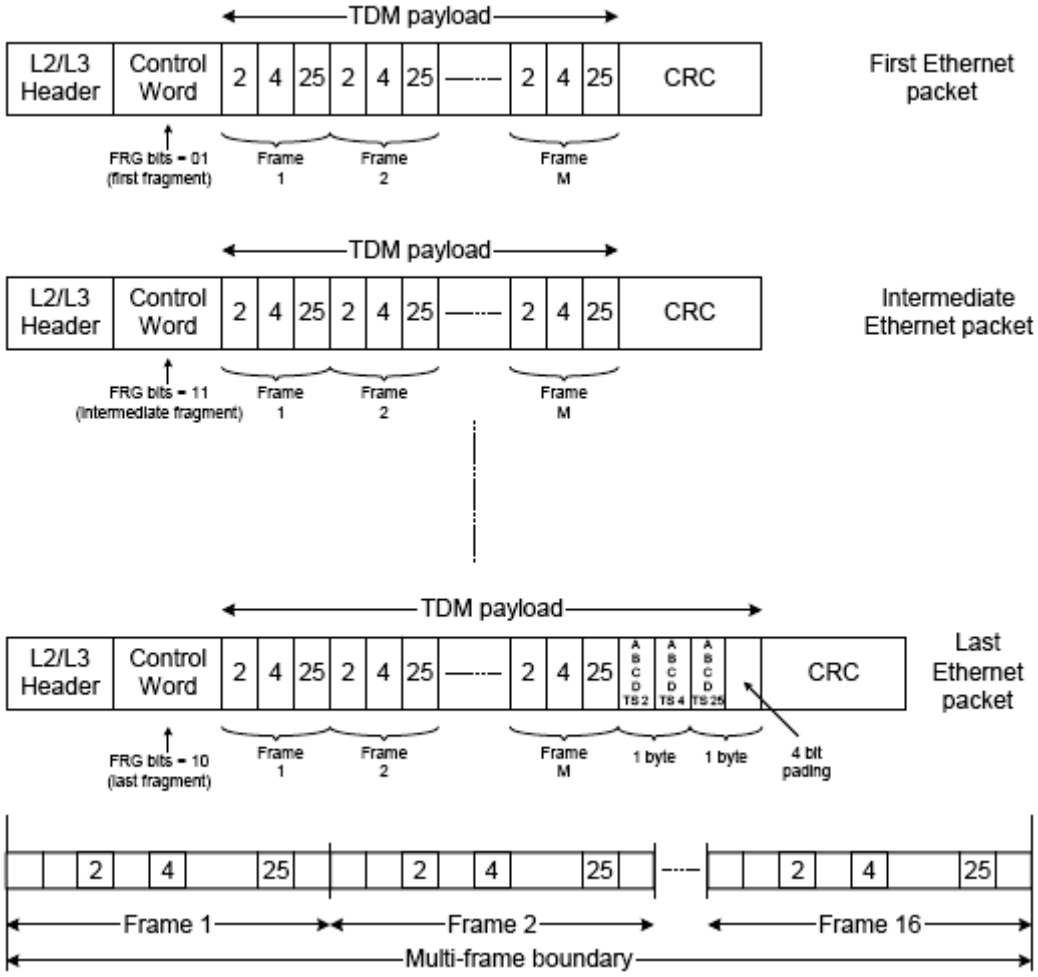


*Figure 1-9. CESoPSN with CAS Encapsulation (E1, Bundle with Timeslots2, 4 and 25)*

## SAToP

The SAToP (Structure Agnostic TDM over Packet) encapsulation method is used to convert unframed E1 data flows into IP or MPLS packets and vice versa according to ITU-T Y.1413 and IETF RFC 4553. It provides flexible packet size configuration and low end-to-end delay.

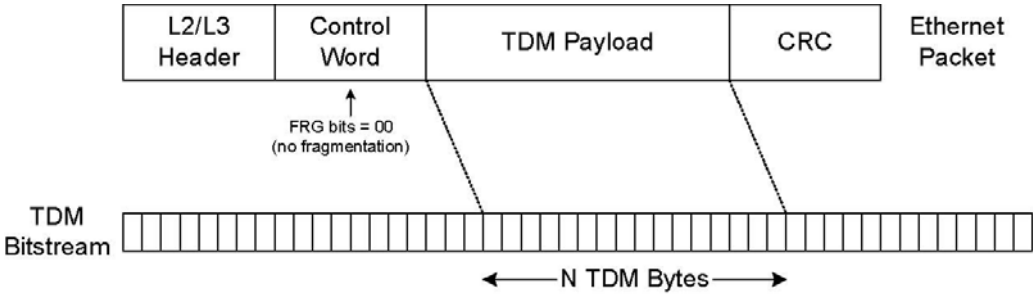


*Figure 1-10. SAToP Encapsulation*

### HDLCoPSN

In addition to the TDMoIP connection mode IPmux-2L supports HDLCoPSN (HDLCoMPLS and HDLCoIP) transmission. This makes IPmux-2L suitable for the following data transfer applications:

- Port-mode Frame Relay (FRAD)
- Transparent X.25 (PAD)
- Transparent PPP (router).

The HDLCoPSN is implemented in IPmux-2L according to the IETF RFC 4618 (excluding clause 5.3 – PPP) and RFC 5087, respectively. The HDLC uses bit stuffing to ensure the bits stream continuity. The HDLC frames include the 16-bit FCS for the frame validity check.

## Packet Delay Variation

TDMoIP packets are transmitted by IPmux-2L at a constant rate towards the PSN (packet-switched network). Packet Delay Variation is the maximum deviation from the nominal time the packets are expected to arrive at the far end device. IPmux-2L has a jitter buffer that compensates for the deviation from the expected packet arrival time to ensure that the TDM traffic is sent to the TDM device at a constant rate.

The jitter buffer needs to be configured to compensate for the jitter level introduced by the PSN. If the PSN jitter level exceeds the configured jitter buffer size, underflow/overflow conditions occur, resulting in errors at the TDM side.

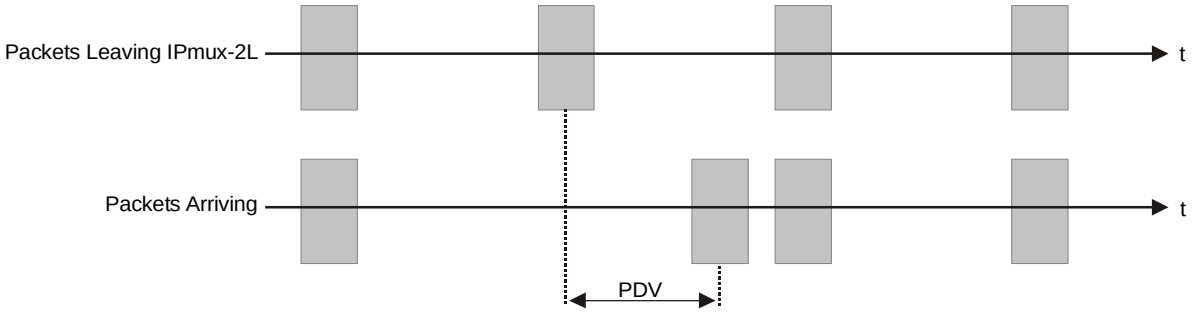


*Figure 1-11. Packet Delay Variation*

### PDVT (Jitter) Buffer

IPmux-2L is equipped with a Packet DVT (Delay Variation Tolerance) buffer. The PDVT buffer or jitter buffer is filled by the incoming packets and emptied out to fill the TDM stream.

- A jitter buffer overrun occurs when it receives a burst of packets that exceeds the configured jitter buffer size plus packetization delay. When an overrun is detected, IPmux-2L clears the jitter buffer, causing an underrun.
- A jitter buffer underrun occurs when no packets are received for more than the configured jitter buffer size, or immediately after an overrun.

When the first packet is received, or immediately after an underrun, the buffer is automatically filled with conditioning pattern up to the PDVT level in order to compensate for the underrun. Then, IPmux-2L processes the packet (packetization delay) and starts to empty out the jitter buffer to the TDM side. See *Figure 1-12* for the illustration of the PDVT buffer operation.

The PDVT (jitter) buffer is designed to compensate for network delay variation of up to 200 msec.

### PDVT Buffer Effect on Delay

Packets arriving from the PSN side are stored in the jitter buffer before being transmitted to the TDM side, adding a delay to the TDM traffic. The delay time equals to the jitter buffer size configured by the user.

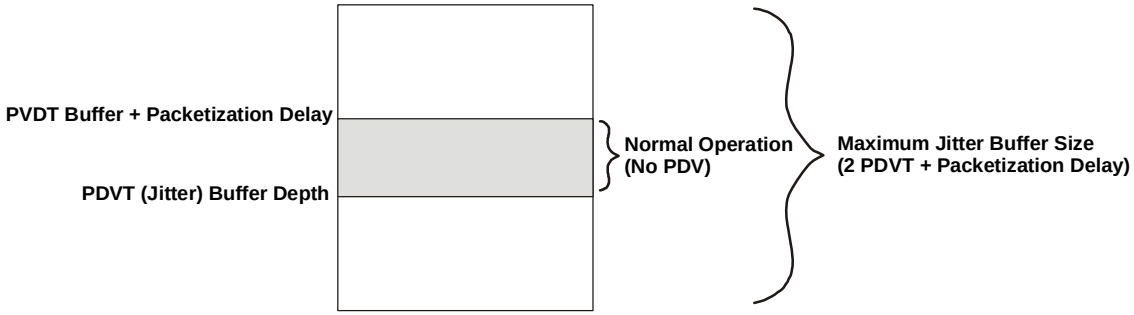


*Figure 1-12. Jitter Buffer Operation*

## Packetization Delay

When IPmux-2L builds a frame, a packetization delay is introduced. The packetization delay is calculated according to the following formula:

**TDMoIP (AAL1 for E1)**

Packetization delay (ms) = $\frac{47 \times N \times 0.125}{TS}$

Where:

N = $\frac{\text{TDM bytes/frame}}{48}$

TS = number of assigned timeslots (in unframed mode= 32)

**CESoPSN (for E1)**

Packetization delay (ms) = N × 0.125

Where:

N = Number of TDM frames in packet

**SAToP (for E1)**

Packetization delay (ms) = N /256

Where:

N = Number of TDM bytes in packet

**SAToP (for HS)**

Packetization delay (ms) = **N** × 0.125 /**K**

Where:

**N** = Number of TDM bytes in packet

**K** = Number of 64Kbps in HS service

## Round Trip Delay

The voice path round-trip delay is a function of all connections and network parameters.

(±2 msec) RT Delay $_{(msec)}$ = 2 × [Packetization delay + PDVT buffer msec] + network round trip delay

## Ethernet Throughput

Increasing payload size reduces the ratio of the TDMoIP/SAToP/CESoPSN header segment in the packet, thus reducing the total Ethernet throughput.

Increased payload reduces the IP/Ethernet overhead segment of the total packet and thus can reduce the total Ethernet throughput.

On the other hand, packetization delay is increased; this contributes to a higher end-to-end delay. This effect can be small and negligible when a full E1 (or many timeslots) are transferred, but can be very significant when few timeslots are transferred.

Configuring the TDM bytes per frame (TDM bytes/frame) parameter has impact on the Ethernet throughput (bandwidth or traffic traveling through the Ethernet). This parameter controls the number of TDM bytes encapsulated in one frame.

The TDM bytes/frame parameter can be configured by user.

➤ **To calculate Ethernet throughput as a function of TDM bytes/frame:**

Ethernet load (bps) = [(frame overhead (bytes) + TDM bytes/frame) × 8] × frames/second

Frame overhead (IP) = Ethernet overhead (18Bytes) + IP overhead (28Bytes) + Control Word (4Bytes) = 50 bytes

Frame overhead (MPLS) = Ethernet overhead (18Bytes) + MPLS overhead (4Bytes) + Control Word (4Bytes) = 26 bytes

***Note*** *The frame overhead does not include:*

- *Preamble field: 7 bytes*
- *SFD field: 1 byte*
- *Interframe gap: 12 bytes*
- *VLAN field (when used): 4 or 8 bytes*
- *MPLS double stack label field (when used): 4 bytes.*

For TDMoIP:

Frame/second =

Unframed: 5447/**n** (for a full E1)

Framed: 8000 × **k**/ (46.875 × **n**)

Where **k** = number of assigned timeslots

Where **n** = $\frac{\text{TDM bytes/frame}}{48}$

For SAToP:

Frame/second = 256,000/**n** (for E1)

8000 × **N** /**n** (for **N** × 64Kbps HS service)

Where **n** = number of TDM bytes in packet

Where **N** = number of 64Kbps in HS service

For CESoPSN:

Frame/second = 8,000/**n** (for E1)

Where **n** = number of TDM frames in packet

=1-1440 (for CESoPSN without CAS)

=1, 2, 4, 8, 16 (for CESoPSN with CAS)

The result in both the equations is in bits per second (bps).

## OAM Connectivity

When connection to a destination IPmux-2L is lost, the traffic load transmitted to that IPmux-2L is significantly decreased (several packets per second per connection). The IPmux-2L starts transmitting at full rate only when it detects an IPmux-2L at the remote side.

OAM connectivity is used to detect a valid connection (the remote IPmux-2L confirms it recognizes the connection and that it is enabled). It prevents flooding by a handshake. The control packets are run over a unique bundle number that is used for this purpose. The control packets have the same VLAN ID and TOS of the originating connection. The control packet uses the TDMoIP UDP number. OAM connectivity can be enabled or disabled.

***Note*** *For control packets, the UDP checksum is neither calculated nor checked.*

## End-to-End Alarm Generation

An end-to-end alarm generation mechanism exists in IPmux-2L to facilitate the following alarms:

- Unframed – AIS is transmitted toward the near-end PBX in event of:
  - Far-end LOS, AIS
  - PDVT underflow/overflow.

- Framed – Timeslot/CAS configurable alarm pattern is transmitted toward the near-end PBX in event of:
  - Far-end LOS, LOF, AIS
  - PDVT underflow/overflow.

## VLAN Traffic Behavior

*Table 1-1* lists the IP and VLAN validity checks that are performed with each Ethernet packet that is received by IPmux-2L.

*Table 1-1. VLAN Check for Packets that are received by IPmux-2L*

| Packet Type | Source IP Check | VLAN Check |
|---|---|---|
| Management | Performed | Performed |
| TDM over IP | Performed | Performed |
| Receiving Ping | Not performed | Not performed, even if it is one of the IPs that is configured for the manager or for the connection |
| ARP | Not performed | |
| Telnet | Performed only when Telnet access mark is from manager | Performed only when Telnet access mark is from manager |

*Table 1-2* lists the IP and VLAN validity checks that are performed with each Ethernet packet that is sent by IPmux-2L.

*Table 1-2. VLAN Check for Packets Sent by IPmux-2L*

| Packet Type | VLAN Support |
|---|---|
| Management | As configured for the manager |
| TDM over IP | As configured for the connection or with the Network Port VID (only for Double Tagged) |
| Answer to Ping | As configured for the network port Egress port behavior in VLAN Membership Table and VLAN Tagging mode in Bridge Port menu |
| ARP initiated by IPmux-2L<br>Telnet | As configured for the network port Egress port behavior in VLAN Membership Table and VLAN Tagging mode in Bridge Port menu |

## Internal Switch

IPmux-2L contains an internal bridge where one of its ports is connected to a TDMoIP internetworking function, three external bridge ports used as the user ports or network port.

The Ethernet user ports allow a user to aggregate both TDMoIP traffic and his private network LAN traffic to a single Ethernet network connection without

requiring an access switch. This is a cost-effective solution for MTU or small-office applications. A rate limiter to restrict user port traffic is supported.

IPmux-2L performs switching at Layer 2. The internal switch supports both transparent/filter bridging and VLAN aware/unaware bridging. It supports up to 1024 MAC addresses (depending on their values and the order in which they are learned). The internal switch supports ingress and egress rate limiting of traffic on the user ports and the network port. The internal switch supports four traffic classes and packets are directed into one of the four traffic classes based on Port, 802.1p, IP precedence or DSCP.

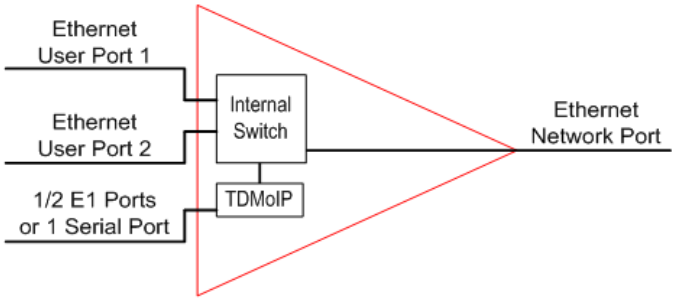


*Figure 1-13. IPmux-2L with Two Ethernet User Ports*

## Internal Switch Operation Modes

IPmux-2L offers two user LAN ports in addition to the LAN port on the network side. The device performs switching at Layer 2. The switch supports both transparent bridging and VLAN-aware bridging. The switch supports rate limiting of traffic going from the user ports to the network port. It supports up to 1024 MAC addresses (depending on their values and the order in which they are learned).

The switch modes are described later in this section. They are:

- Transparent
- Untagged
- Tagged
- Double tagged.

*Table 1-3* illustrates relations between rate limiting and VLAN tagging modes.

*Table 1-3. Rate Limiting and VLAN Tagging Modes*

| VLAN Mode | Forwarding Mode | Operation |
|---|---|---|
| Aware | Transparent | Not Learning and all frames received flooding to other ports in VLAN domain |
| Aware | Filter | Independent VLAN Learning and Forwarding Process based on MAC Address Table |
| Unaware | Transparent | Not Learning and all frames received flooding to other ports (not dependent on VLAN). |
| Unaware | Filter | Learning and Forwarding Process based on MAC Address Table |

## Port Egress Behavior in VLAN Membership Table

*Table 1-4* lists the egress behavior for a specified VLAN ID, which is performed when a packet that will be transmitted from the designated Eth ports.

*Table 1-4. Port Egress Behavior for a specified VLAN ID*

| Egress Port Type | Egress Frame Type |
|---|---|
| Egress Unmod Port | Unmodified, same as the received frames, including VLAN ID and PRI |
| Egress Tagged Port | Tagged, it maybe replace the PRI of received frames in some packets classification conditions |
| Egress Untagged Port | Untagged |

## Switch Behavior When Handling User and Network Traffic

When internal switch VLAN mode is Aware, the way the network and user ports handle the traffic depends on the selected port mode (transparent, untagged, tagged or double tagged) and frame type (untagged, tagged or double tagged). *Table 1-5* lists all operation modes of the network and user ports. The modes are explained in greater detail in the following tables:

*Table 1-5. Switch Behavior (User and Network Traffic)*

| User \ Network | Transparent | Untagged | Tagged | Double Tagged |
|---|---|---|---|---|
| **Transparent** | Mode A | Mode B | Mode C | Mode G |
| **Untagged** | Mode B | Mode D | Mode E | Not implemented |
| **Tagged** | Mode C | Mode E | Mode F | Not implemented |
| **Double Tagged** | Not applicable | Not applicable | Not applicable | Not applicable |

*Table 1-6. Mode A*

| Ingress | Egress |
|---|---|
| If a tagged frame enters a transparent port, it is switched to the other transparent port | • If the transparent port is a member of the frame's VID, the transparent port transmits the frame according to VLAN Table<br>• If the transparent port is not a member of the frame VID, the transparent port transmits the frame unmodified (tagged) |
| If an untagged frame enters a transparent port, which is a member of its Default VID, the port adds tag (VID is the transparent port default VID and PRI is the transparent port default PRI) and switches the frame to all other members | The transparent port transmits the frame according to VLAN Table |
| If an untagged frame enters a transparent port, which is not a member of its Default VID, the port switches the frame to the other transparent port | The transparent port transmits the frame unmodified (untagged) |

*Table 1-7. Mode B*

| Ingress | Egress |
|---|---|
| If a tagged frame enters the transparent port, it is switched to the untagged port | • If the transparent port is a member of the frame VID, the untagged port transmits the frame according to VLAN Table<br>• If the transparent port is not a member of the frame VID, the untagged port removes the tag, and transmits the frame untagged |
| If a tagged frame enters the untagged port, it is switched to the transparent port | • If the transparent port is a member of the frame VID, the transparent port transmits the frame according to VLAN Table<br>• If the transparent port is not a member of the frame VID, the transparent port transmits the frame unmodified (tagged) |
| If an untagged frame enters the transparent port, which is a member of its Default VID, the port adds tag (VID is the transparent port default VID and PRI is the transparent port default PRI) and switches the frame to all other members | The untagged port transmits the frame according to VLAN Table |
| If an untagged frame enters the transparent port, which is not a member of its Default VID, the port switches the frame to the other untagged port | The untagged port transmits the frame unmodified (untagged) |

| Ingress | Egress |
|---|---|
| If an untagged frame enters the untagged port, which is a member of its Default VID, the port adds tag (VID is the untagged port default VID and PRI is the untagged port default PRI) and switches the frame to all other members | The transparent port transmits the frame according to VLAN Table |
| If an untagged frame enters the untagged port, which is not a member of its Default VID, the port switches the frame to the other transparent port | The transparent port transmits the frame unmodified (untagged) |

*Table 1-8. Mode C*

| Ingress | Egress |
|---|---|
| If a tagged frame enters the transparent port, it is switched to the tagged port | • If the transparent port is a member of the frame VID, the tagged port transmits the frame according to VLAN Table<br>• If the transparent port is not a member of the frame VID, the tagged port transmits the frame unmodified (tagged) |
| • If a tagged frame enters the tagged port, which is not a member of its VID, the frame is discarded<br>• If a tagged frame enters the tagged port, which is a member of its VID, the frame is switched to all other members | The transparent port transmits the frame according to VLAN Table |
| If an untagged frame enters the transparent port, which is a member of its Default VID, the port adds tag (VID is the transparent port default VID and PRI is the transparent port default PRI) and switches the frame to all other members | The tagged port transmits the frame according to VLAN Table. |
| If an untagged frame enters the transparent port, which is not a member of its Default VID, the port switches the frame to the other tagged port | The tagged port transmits the frame unmodified (untagged) |
| • If an untagged frame enters the tagged port, which is not a member of its default VID, the frame is discarded<br>• If an untagged frame enters the tagged port, which is a member of its Default VID, the port adds tag (VID is the tagged port default VID and PRI is the tagged port default PRI) and switches the frame to all other members | The transparent port transmits the frame according to VLAN Table |

*Table 1-9. Mode D*

| Ingress | Egress |
|---|---|
| If a tagged frame enters an untagged port, it is switched to the other untagged port | • If the untagged port is a member of the frame's VID, the untagged port transmits the frame according to VLAN Table<br>• If the untagged port is not a member of the frame's VID, the untagged port removes the tag, and transmits the frame untagged |
| If an untagged frame enters an untagged port, which is a member of its Default VID, the port adds tag (VID is the untagged port default VID and PRI is the untagged port default PRI) and switches the frame to all other members | The untagged port transmits the frame according to VLAN Table |
| If an untagged frame enters an untagged port, which is not a member of its Default VID, the port switches the frame to the other untagged port | The untagged port transmits the frame unmodified (untagged) |

*Table 1-10. Mode E*

| Ingress | Egress |
|---|---|
| If a tagged frame enters the untagged port, it is switched to the tagged port | • If the tagged port is a member of the frame's VID, the tagged port transmits the frame according to VLAN Table<br>• If the tagged port is not a member of the frame's VID, the tagged port transmits the frame unmodified (tagged) |
| • If a tagged frame enters the tagged port, which is not a member of its VID, the frame is discarded<br>• If a tagged frame enters the tagged port, which is a member of its VID, the frame is switched to all other members | The untagged port transmits the frame according to VLAN Table |
| If an untagged frame enters the untagged port, which is a member of its Default VID, the port adds tag (VID is the untagged port default VID and PRI is the untagged port default PRI) and switches the frame to all other members | The tagged port transmits the frame according to VLAN Table |
| If an untagged frame enters the untagged port, which is not a member of its Default VID, the port switches the frame to the other tagged port | The tagged port transmits the frame unmodified (untagged) |

| Ingress | Egress |
|---|---|
| • If an untagged frame enters the tagged port, which is not a member of its default VID, the frame is discarded<br>• If an untagged frame enters the tagged port, which is a member of its Default VID,the port adds tag (VID is the tagged port default VID and PRI is the tagged port default PRI) and switches the frame to all other members | The untagged port transmits the frame according to VLAN Table |

*Table 1-11. Mode F*

| Ingress | Egress |
|---|---|
| • If a tagged frame enters a tagged port, which is not a member of the frame VID, the frame is discarded<br>• If a tagged frame enters a tagged port, which is a member of the frame VID, the frame is switched to all other members | The tagged port transmits the frame according to VLAN Table |
| • If an untagged frame enters a tagged port, which is not a member of its default VID, the frame is discarded<br>• If an untagged frame enters a tagged port, which is a member of its Default VID,the port adds tag (VID is the tagged port default VID and PRI is the tagged port default PRI) and switches the frame to all other mermbers | The tagged port transmits the frame according to VLAN Table. |

*Table 1-12. Mode G*

| Ingress | Egress |
|---|---|
| • If a double-tagged frame enters the double-tagged port, which is not a member of the first VID of the frame, the frame is discarded<br>• If a double-tagged frame enters the double-tagged port, which is a member of the first VID of the frame, the double-tagged port removes the first tag and switches the frame to the transparent port | The transparent port transmits the frame unmodified (tagged) |
| • If a tagged frame enters the double-tagged port, which is not a member of the frame VID, the frame is discarded<br>• If a tagged frame enters the double-tagged port, which is a member of the frame VID,the double-tgged port removes the tag and switches the frame to the transparent port | The transparent port transmits the frame unmodified (untagged) |

| Ingress | Egress |
|---|---|
| If an untagged frame enters the double tagged port, the frame is discarded | |
| If a tagged frame enters the transparent port, the port adds tag (VID is the transparent port default VID and PRI is the transparent port default PRI), and switches the frame to the double-tagged port. | The double-tagged port transmits the frame unmodified (double tagged) |
| If an untagged frame enters the transparent port, the port adds tag (VID is the transparent port default VID and PRI is the transparent port default PRI), and switches the frame to the double-tagged port | The double-tagged port transmits the frame unmodified (tagged) |

***Note***

*If Egress Unmod Ports Egress Tagged Ports Egress Untagged Ports all are None for an VLAN ID in VLAN Membership table, the frames with the VLAN ID will be discarded in IPmux-2L.*

*When operating in the Mode G, the following rules apply:*

- *Network port can only be a member of its default VLAN ID, no other VLANs are valid*
- *Each user port can only be a member of its default VLAN ID, no other VLANs are valid.*
- *Both user ports can get the same default VLAN ID.*
- *Both user ports must be Transparent port.*

## Rate Limiter

A rate limiter is available to limit user port traffic. This feature is valuable when a limited bandwidth is used to extend the Ethernet link (generally when the Ethernet link rate is limited/shaped to a lower rate after IPmux-2L). In this case TDMoIP packets will be dropped by a lower-rate device even if it was prioritized at the IPmux-2L internal switch. This is prevented by limiting the user port to actual link rate minus TDMoIP bandwidth.

Network and user traffic can be limited to the following data rates:

- Network interface (ingress/egress) –Disable, 256 kbps, 512 kbps, 1 Mbps, 2 Mbps, 3 Mbps, 3.5 Mbps, 4 Mbps, 4.5 Mbps, 8 Mbps, 10 Mbps, 16 Mbps, 20 Mbps, 25Mbps, 40 Mbps, 50 Mbps, 80 Mbps
- User interface (ingress/egress) –Disable, 256 kbps, 512 kbps, 1 Mbps, 2 Mbps, 3 Mbps, 3.5 Mbps, 4 Mbps, 4.5 Mbps, 8 Mbps, 10 Mbps, 16 Mbps, 20 Mbps, 25Mbps, 40 Mbps, 50 Mbps, 80 Mbps

When the rate limiter is disabled, there is automatic per-port ingress limiting of 64 Mbps on every user port, for protection against broadcast, multicast, and flooding, which could otherwise saturate the channel. If the default VLAN priority is lowered, then this automatic limit is lowered accordingly, to maintain this protection. Setting the default VLAN priority changes the automatic rate limiting in the following manner:

*Table 1-13. Automatic Per-Port Rate Limiting*

| Default VLAN Priority | Automatic Rate Limiting |
|---|---|
| 4–7 | 64 Mbps |
| 2–3 | 32 Mbps |
| 0–1 | 16 Mbps |

## QoS

The internal switch support four traffic class (0 – low, 3 – high), and it uses Port, 802.1p, IP precedence or DSCP to determine the output queues for those Ethernet frames which should be transmitted . The switch provides two queue scheduling modes: strict priority and 8-4-2-1 weighted fair queuing.

***Note*** *The two user ports and the network port can select their own traffic mapping schemes, but IP precedence and DSCP can not be used at the same time*

## 1.4 Technical Specifications

### E1 Interface

| | |
|---|---|
| *Number of Ports* | 1 or 2 |
| *Compliance* | ITU-T Rec. G.703, G.704, G.706, G.732, G.823 |
| *Data Rate* | 2.048 Mbps |
| *Line Code* | HDB3/AMI |
| *Framing* | Unframed, framed, multiframe; with or without CRC-4 |
| *Signaling* | CAS, CCS (transparent) |
| *Line Impedance* | Balanced: 120Ω; unbalanced: 75Ω |
| *Signal Levels* | Receive: 0 to -36 dB with LTU (long haul)<br>0 to -10 dB without LTU (short haul)<br>Transmit pulse amplitude, balanced: ±3V ±10%<br>Transmit pulse amplitude, unbalanced: ±2.37V ±10% |
| *Jitter Performance* | As per ITU-T G.823 |
| *Connector* | Balanced: RJ-45<br>Unbalanced: Two BNC coax |

### Serial Interface

| | |
|---|---|
| *Number of Ports* | 1 |
| *Data Rate* | N × 64 kbps (N = 1, 2, ... 32) |
| *Timing* | DCE – Rx and Tx clock is supplied by the data port<br>DTE1 – Rx clock is derived from the system clock, internal clock or adaptive clock, and Tx clock is supplied by the equipment connected to the data port<br>DTE2 – Rx and Tx clock is supplied by the equipment connected to the data port |
| *Control Signals* | CTS – constantly ON or follows RTS, user-selectable<br>DCD – constantly ON, unless a fault in the PSN network is detected<br>DSR – constantly ON |
| *Connector* | 25-pin, D-type, female |

| | | |
|---|---|---|
| | *Number of Ports* | Fiber: 1<br>Copper: up to 2 (each port can be a user or network interface) |
| **Ethernet** | *Type* | Copper: 10/100BaseT<br>Fiber optic: 100BaseFx, 100BaseLX10, 100BaseBx10 |
| | *Frame Size* | 2048 bytes max (user port) |
| | *Fiber Optic Specifications* | See SFP Transceivers data sheet |
| | *Connector* | LC, SFP-based |
| **Timing** | *Transmit* | • Internal<br>• External input or output via E1 port<br>• Loopback<br>• Adaptive |
| **Pseudowire Connections** | *Number of Connections* | 63 (31 bundles per E1, and 1 bundle per serial data port) |
| | *Standard Compliance* | • IETF: RFC 4553 (SAToP)<br>• IETF: RFC 5086 (CESoPSN)<br>• IETF: RFC 5087 (TDMoIP)<br>• ITU-T: Y.1413 |
| | *Jitter Buffer Size* | • 0.5–200 msec (unframed) with 0.1 msec granularity<br>• 1.5–200 msec (framed) with 0.5 msec granularity |
| **Management** | *Methods* | • SNMPv1v2c<br>• Telnet<br>• Web (ConfiguRAD)<br>• RADview EMS/NGN (ordered separately)<br>• ASCII terminal via RS-232 DCE port |
| **Diagnostics** | *Loopbacks* | • E1 local loopback<br>• E1 remote loopback<br>• HS local loopback<br>• HS remote loopback |
| | *BERT* | • E1 internal BERT<br>• E1 external BERT |

| | | |
|---|---|---|
| **Statistics** | *E1* | As per G.826 and RFC 2495 |
| | *Ethernet* | As per RFC 2819 |
| | *Receive Buffer Indication* | Overflow, Underflow, Sequence error, Min/Max jitter buffer level, Max jitter buffer deviation |
| **Indicators** | *General* | PWR (green) – Power status |
| | | TST (yellow) – Test status |
| | | ALM (red) – Alarm status |
| | *E1* | LOC/REM (red/red) – E1 local/remote sync loss |
| | *Ethernet* | LINK/ACT (green/yellow) – Ethernet link/activity status on RJ-45 or SFP |
| **Power** | *AC/DC Source* | 100–240 VAC, 50/60 Hz or 48/60 VDC nominal (40 to 72 VDC) |
| | *Power Consumption* | 10W max |
| **Physical** | *Height* | 43 mm (1.7 in) |
| | *Width* | 217 mm (8.5 in) |
| | *Depth* | 170 mm (6.7 in) |
| | *Weight* | 0.5 kg (1.1 lb) |
| **Environment** | *Temperature* | 0°C to 50°C (32°F to 122°F) |
| | *Humidity* | Up to 90%, non-condensing |

# Chapter 2

# Installation and Setup

This chapter describes installation and setup procedures for the IPmux-2L unit.

After installing the unit, refer to *Chapter 3* for the operating instructions.

If a problem is encountered, refer to *Chapter 6* for test and diagnostic instructions.

***Warning***

**Internal settings, adjustment, maintenance, and repairs may be performed only by a skilled technician who is aware of the hazards involved.**

**Always observe standard safety precautions during installation, operation, and maintenance of this product.**

***Note***

*Before installing the product, review Handling Energized Products at the beginning of the manual.*

## 2.1 Site Requirements and Prerequisites

The IPmux-2L device is intended for installation on desktop, 19-inch racks and walls. All the connections are made at the rear panel.

AC-powered IPmux-2L units should be installed within 1.5m (5 ft) of an easily-accessible grounded AC outlet capable of furnishing the voltage in accordance with IPmux-2L nominal supply voltage.

DC-powered IPmux-2L units require a -48 VDC power source, which must be adequately isolated from the main supply.

Allow at least 90 cm (36 in) of frontal clearance for operating and maintenance accessibility. Allow at least 10 cm (4 in) clearance at the rear of the unit for signal lines and interface cables.

The ambient operating temperature of IPmux-2L must be 0°C to 50°C (32°F to 122°F), at a relative humidity of up to 90%, non-condensing.

## 2.2 Package Contents

The IPmux-2L package includes the following items:

- One IPmux-2L unit
- Power cord
- IEC 60320 AC/DC adapter plug

- CBL-RJ45/2BNC/E1/X adapter cable for unbalanced E1 interface (if ordered)
- Matching adapter cable for the serial data port (if ordered)
- CBL-DB9F-DB9M-STR control port cable (if ordered)
- RM-33-2 rack mount kit (if ordered).

## 2.3 Mounting the Unit

IPmux-2L is designed for installation as a desktop unit. It can also be mounted in a 19" rack or on a wall.

- For rack mounting instructions, refer to RM-33-2 installation kit manual
- For wall mounting instructions, refer to drilling template at the end of the manual.

Refer to the clearance and temperature requirements in *Site Requirements and Prerequisites*.

## 2.4 Connecting to the Ethernet Equipment

IPmux-2L is connected to the network or user Ethernet equipments via:

- 8-pin RJ-45 copper interfaces designated ETH 1 and ETH 2. (*Appendix A* shows the RJ-45 connector pinout.)
- Fiber optic LC interface designated ETH 3.

### Connecting the Copper Interface

*Figure 2-1* illustrates a typical rear panel of an IPmux-2L unit with two copper interfaces.

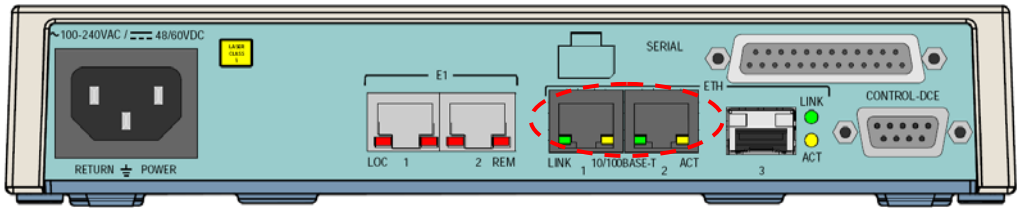


*Figure 2-1. ETH 1 and ETH 2 Connectors*

➤ **To connect Ethernet equipment to the copper interface:**

- Connect IPmux-2L to the network or user Ethernet equipment using a standard straight or cross UTP cable terminated with an RJ-45 connector.

## Connecting the Fiber Optic Interface

*Figure 2-2* illustrate a typical rear panel of an IPmux-2L unit with fiber optic LC network connectors.

➤ **To connect network Ethernet equipment to an LC connector:**

- Connect IPmux-2L to the network or user Ethernet equipment using a standard fiber optic cable terminated with an LC connector.

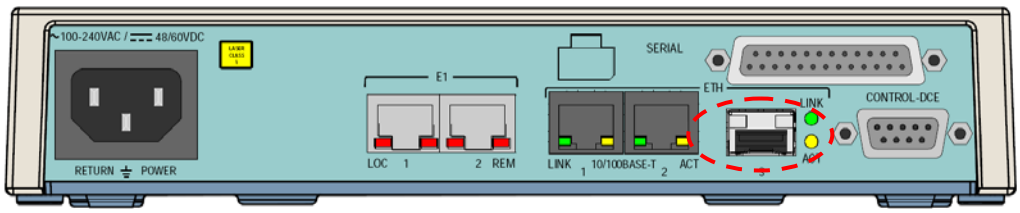


*Figure 2-2. ETH 3 Fiber Optic LC Connector*

# 2.5 Connecting to the E1 Devices

E1 devices are connected to IPmux-2L via two balanced RJ-45 ports or two unbalanced BNC ports designated E1 1–2.

An unbalanced E1 interface can also be provided via adapter cable CBL-RJ45/2BNC/E1/X (see *Appendix A* for the connector pinouts and cable wiring diagram).

***Caution***

When connecting balanced E1 equipment, make sure to use only 4-wire RJ-45 connectors with the following pins used for receiving and transmitting data: 1, 2, 4, 5. Do not use 8-pin RJ-45 connectors.

*Figure 2-3* and *Figure 2-4* illustrate typical rear panels of the IPmux-2L unit with RJ-45 or BNC ports, respectively.

## Connecting to E1 Devices with Balanced Interfaces

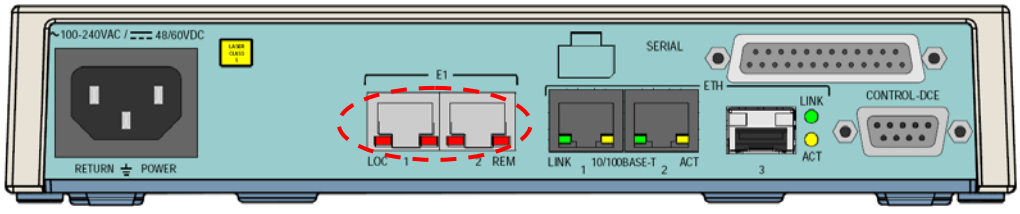


*Figure 2-3. E1 1-2 RJ45 Connectors*

➤ **To connect to the E1 devices with balanced interfaces:**

- Connect IPmux-2L to the E1 devices using standard straight E1 cables.

## Connecting to the E1 Devices with Unbalanced Interfaces

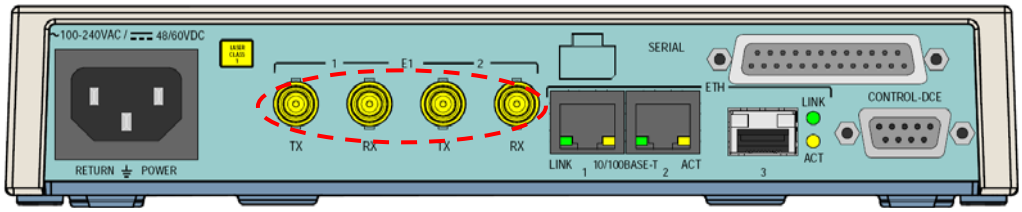


*Figure 2-4. E1 1-2 BNC Connectors*

➤ **To connect to the E1 devices with unbalanced interfaces:**

1. Connect the transmit cable to the IPmux-2L unbalanced BNC ports marked TX.
2. Connect the receive cable to the IPmux-2L unbalanced BNC ports marked RX.

➤ **To connect to the E1 devices with unbalanced interfaces, using the CBL-RJ45/2BNC/E1/X adapter cable:**

1. Connect the RJ-45 connector of the CBL-RJ45/2BNC/E1/X adapter cable to the IPmux-2L balanced RJ-45 ports designated E1 1-2.
2. Connect the transmit cable to the red coaxial connector of the adapter cable marked ↑.
3. Connect the receive cable to the green coaxial connector of the adapter cable marked ↓.

## 2.6 Connecting to the Devices with Serial Data Ports

The serial data interface (also called high-speed or HS interface) of an IPmux-2L is terminated in a 25-pin D-type female connector. The 25-pin D-type connector wiring is given in *Appendix A*. The interface type is RS-530/RS-422, V.35, V.36/RS-449 or X.21, according to order.

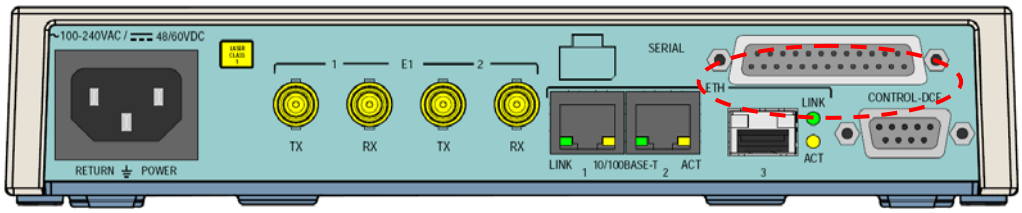


*Figure 2-5. DATA DB-25 Connector*

The data port cables for DCE and DTE (DTE1 and DTE2) clock modes can be prepared in accordance with the port connector wiring information given in *Appendix A* or ordered separately from RAD. The use of each cable is listed in *Table 2-1*. Cable length is 2m (6.5 ft).

*Table 2-1. IPmux-2L Serial Interface Adapter Cables*

| Cable | User Interface | Clock Mode |
|---|---|---|
| CBL-HS2V1 | V.35 | DCE |
| CBL-HS2V2 | V.35 | DTE1 |
| CBL-HS2V3 | V.35 | DTE2 |
| CBL-HS2R1 | V.36/RS-449 | DCE |
| CBL-HS2R2 | V.36/RS-449 | DTE1 |
| CBL-HS2R3 | V.36/RS-449 | DTE2 |
| CBL-HS2X1 | X.21 | DCE |

➤ **To connect to a device with an RS-530 serial interface:**

1. Connect the DB-25 side of a standard RS-530 cable to the serial data interface connector of IPmux-2L, designated SERIAL.
2. Connect the user side of the cable to the appropriate connector of the user's equipment.

➤ **To connect to a device with a V.35 serial interface:**

1. Connect the DB-25 side of the CBL-HS2V1 cable (DCE mode), CBL-HS2V2 (DTE1 mode), or CBL-HS2V3 (DTE2 mode) to the serial data interface connector of IPmux-2L, designated SERIAL.
2. Connect the 34-pin side of the adapter cable to the appropriate connector of the user's equipment.

➤ **To connect to device with V.36/RS-449 serial interface:**

1. Connect the DB-25 side of the CBL-HS2R1 cable (DCE mode), CBL-HS2R2 (DTE1 mode) or CBL-HS2R3 (DTE2 mode) to the serial data interface connector of IPmux-2L, designated SERIAL.
2. Connect the DB-37 side of the adapter cable to the appropriate connector of the user's equipment.

➤ **To connect to a device with an X.21 serial interface:**

1. Connect the DB-25 side of the CBL-HS2X1 cable (DCE mode) mode to the serial data interface connector of IPmux-2L, designated SERIAL.
2. Connect the DB-15 side of the adapter cable to the appropriate connector of the user's equipment.

## 2.7 Connecting to the ASCII Terminal

IPmux-2L is connected to an ASCII terminal via a 9-pin D-type female connector designated CONTROL DCE. Refer to *Appendix A* for the connector pinout.

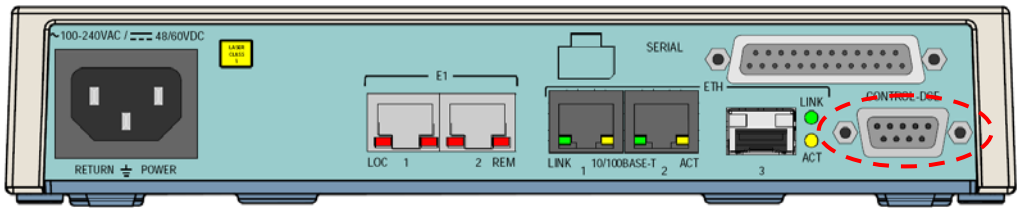


*Figure 2-6. CONTROL DCE Connector*

➤ **To connect to an ASCII terminal:**

1. Connect the male 9-pin D-type connector of CBL-DB9F-DB9M-STR straight cable available from RAD to the CONTROL connector.
2. Connect the other connector of the CBL-DB9F-DB9M-STR cable to an ASCII terminal.

***Caution*** Terminal cables must have a frame ground connection. Use ungrounded cables when connecting a supervisory terminal to a DC-powered unit with floating ground. Using improper terminal cable may result in damage to supervisory terminal port.

## 2.8 Connecting IPmux-2L to Power

IPmux-2L accepts either 110–240 VAC or 48/60 VDC power through the same power inlet.

***Warning***

**Before connecting or disconnecting any cable, the protective earth terminals of this unit must be connected to the protective ground conductor of the mains (AC or DC) power cord. If you are using an extension cord (power cable) make sure it is grounded as well.**

**Any interruption of the protective (grounding) conductor (inside or outside the instrument) or disconnecting of the protective earth terminal can make this unit dangerous. Intentional interruption is prohibited.**

### Connecting to AC Power

AC power is supplied to IPmux-2L through a standard 3-prong socket via a 1.5m (5 ft) standard power cable terminated by a standard 3-prong socket. A cable is provided with the unit.

➤ **To connect to AC power:**

1. Connect the power cable to the power connector on the IPmux-2L rear panel.
2. Connect the power cable to the mains outlet.

   The unit turns on automatically.

## Connecting to DC Power

A special IEC 60320 adapter for the 48/60 VDC power connection is supplied with the unit.

➤ To connect DC power:

- Refer to the DC power supply connection supplement for instructions how to wire the DC cables. The DC supplement is provided at the end of the manual.

# Chapter 3

# Operation

This chapter:

- Provides a detailed description of the front panel indicators and their functions
- Explains power-on and power-off procedures
- Provides instructions for configuration using a terminal connected to the IPmux-2L control port
- Illustrates the management menus.

For a detailed explanation of parameters on the menus, see *Chapter 4*.

## 3.1 Turning IPmux-2L On

➤ To turn on IPmux-2L:

- Connect the power cord to the mains.

  The PWR indicator lights up and remains lit as long as IPmux-2L receives power.

Once it is powered up, IPmux-2L operates automatically. IPmux-2L requires no operator attention once installed, with the exception of occasional monitoring of front panel indicators. Intervention is only required when IPmux-2L must be configured to its operational requirements, or diagnostic tests are performed.

## 3.2 Indicators

LEDs are located on the front and rear panels (see *Figure 3-1*, *Figure 3-2*, and *Figure 3-3*. *Table 3-1* lists the functions of the IPmux-2L LED indicators.

There are three LEDs on the front panel of the IPmux-2L, to indicate the power and device status.

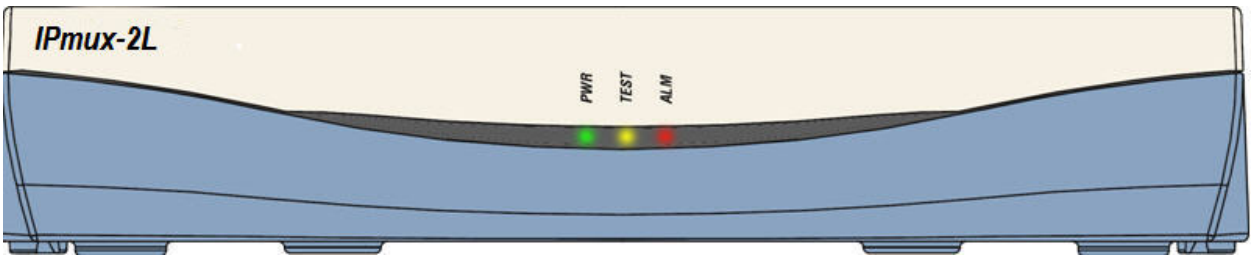


*Figure 3-1. IPmux-2L Front Panel*

*Table 3-1. Front Panel LEDs*

| Name | Type | Function |
|---|---|---|
| PWR | Green LED | ON – IPmux-2L is powered<br>OFF – IPmux-2L is off |
| TEST | Yellow LED | ON – Test is in progress<br>OFF – No test in progress |
| ALM | Red LED | ON – Alarms are detected in the current alarm list<br>OFF – No alarm currently detected |

On the rear panel, each Ethernet port provides two link status indicators: Link and ACT; and each RJ-45 E1 port provides two status indicators: E1_LOC and E1_REM (see *Figure 3-2*.) *Table 3-1* lists the functions of the IPmux-2L LED indicators on rear panel.

BNC E1 port does have LED indicators.

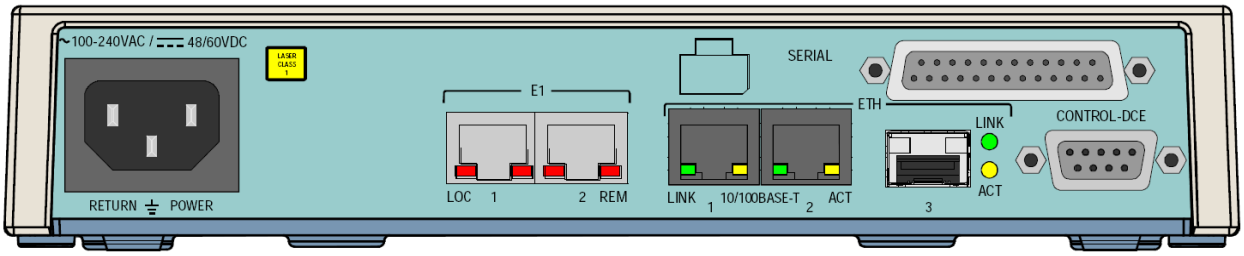


*Figure 3-2. Rear Panel (RJ-45 E1 port)*

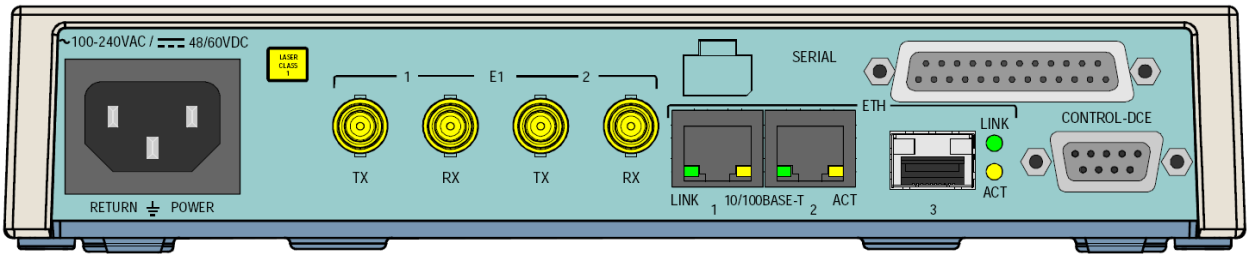


*Figure 3-3. Rear Panel (BNC E1 port)*

*Table 3-2. Rear Panel LEDs*

| Name | Type | Function |
|---|---|---|
| E1 LOC | Red LED | ON – Synchronization loss is detected (LOS/LOF or AIS in Rx)<br>OFF – The E1 link is synchronized |
| E1 REM | Red LED | ON – RDI is detected (remote alarm)<br>OFF – The E1 link is ok |
| ETH LINK | Green LED | ON – Ethernet link is OK<br>OFF – The line is not active |
| ETH ACT | Yellow LED | ON – Data is being transmitted and received on the network Ethernet link<br>OFF – The line is no activity |

## 3.3 Default Settings

The following table lists the default settings of the IPmux-2L configuration parameters.

*Table 3-3. Default Settings*

| Type | | Parameter | Default Value |
|---|---|---|---|
| System | Manager Host IP | IP Address | 0.0.0.0 |
| | | IP Mask | 0.0.0.0 |
| | | Default Gateway | 0.0.0.0 |
| | | DHCP | Enable |
| | | DHCP Server IP | 0.0.0.0 |
| | Service Host IP | IP Address | 0.0.0.0 |
| | | IP Mask | 0.0.0.0 |
| | | Default Next Hop | 0.0.0.0 |
| | System Clock | Master Clock | Internal |
| | | Master Source | TDM Channel 1 |
| | | Fall Back Clock | None |
| | | Fall Back Source | TDM Channel 1 |
| | Date/Time | Set Time | 00:00:00 |
| | | Set Date | 1970-01-01 |
| | Control Port | Baud Rate | 115200 |

| Type | | Parameter | Default Value |
|---|---|---|---|
| Management | Device Info | System Name | System name |
| | | System Location | The Location of the Device |
| | | Contact Person | Contact person |
| | User Access | User Name | SU |
| | | Permission | Full control |
| | | Access | All |
| | Management Access | Session Timeout | 900 |
| | | Telnet Access | Enable |
| | | Web Access | Enable |
| | | SNMP Access | Enable |
| | Authentication/ Community | SNMP Authentication Failure Trap | Disable |
| | | SNMP Trap Community | SNMP_trap |
| | | SNMP Read Community | public |
| | | SNMP Write Community | private |
| | Manager List | Manager IP Address | 0.0.0.0 |
| | | VLAN Tagging | Disable |
| | | VLAN ID | 1 |
| | | VLAN Priority | 3 |
| | | Alarm Trap Mask | Empty |
| Physical Layer | TDM | Admin Status | Enable |
| | | Transmit Clock Source | System |
| | | Source Clock Quality | other/unknown |
| | | Rx Sensitivity | Short haul |
| | | Line Type | Unframed |
| | | Line Code | HDB3 |
| | | Idle Code | 7e |
| | | Send Upon Fail | OOS code |
| | | OOS Code | ff |
| | | OOS Signaling | Space |
| | | Mark Signaling Code | d |
| | | Space Signaling Code | 1 |
| | HS | Admin Status | Enable |
| | | Clock Mode | DCE |
| | | Clock Source | System |

| Type | | Parameter | Default Value |
|---|---|---|---|
| | HS (cont.) | Source Clock Quality | other/unknown |
| | | Clock Polarity | Normal |
| | | Speed (x64kbps) | 0 |
| | | CTS | ON |
| | Ethernet | Admin Status | Enable |
| | | Auto Negotiation | Disable for fiber optic interface<br>Enable for copper interface |
| | | Flow Control | Disable |
| | | Max Capability Advertised/Speed and Duplex | 100baseT full duplex |
| Connection | | Bundle ID | 1 |
| | | Connection Mode | TDMoIP CE |
| | | PSN Type | UDP/IP |
| | Bundle Connection | Destination IP address | 0.0.0.0 |
| | | Next hop | 0.0.0.0 |
| | | IP TOS | 0 |
| | | Outbound label tagging | Disable |
| | | Outbound tunnel label | 16 |
| | | Outbound EXP bits | 7 |
| | | Connection status | Disable |
| | | Destination bundle | 1 |
| | | Source bundle | 1 |
| | | TDM payload (x48 bytes) | 1 |
| | | Far end type | E1 |
| | | OAM connectivity | Enable |
| | | Jitter buffer (msec) | 5.0 |
| | | Clock recovery | Disable |
| | | OOS mode | TX OOS |
| | | VLAN tagging | Disable |
| | | VLAN ID | 1 |
| | | VLAN Priority | 7 |

| Type | | Parameter | Default Value |
|---|---|---|---|
| Ethernet Service | Bridge | VLAN Mode | Aware |
| | | Forwarding Mode | Filter |
| | | Aging Time | 300 |
| | | Static MAC Table | Empty |
| | | Port Role | Eth3 – network port<br>Eth1, Eth2 – user port |
| | | VLAN Tagging | Transparent |
| | | Port VID | 1 |
| | | Default Priority Tag | 5 for user ports<br>7 for network port |
| | | VLAN Mermbership | VID=1<br>Egress Unmod<br>Ports (Eth1, Eth2, Eth3) |
| | QoS | Scheduler Mode | Strict priority |
| | | Classification Selection | Port default priority |
| | | Rate Limitation | Egress: Disable<br>Ingress: Disable |

## 3.4 Configuration Alternatives

If required, IPmux-2L can be reconfigured. The IPmux-2L configuration and monitoring operations are performed using any of the following tools:

- ASCII terminal connected to supervisory port
- ConfiguRAD, a Web-based management system, using a Web browser running on a PC connected to the network
- RADview, an SNMP–based management system with a graphical user interface. See RADview-EMS User's Manual for details.

Detailed configuration procedures are given in *Chapter 4*.

The following functions are supported by the IPmux-2L management software*:*

- Viewing system information
- Modifying configuration and mode of operation, including setting system default values
- Monitoring IPmux-2L performance
- Initiating diagnostic tests
- Uploading and downloading software and configuration files.

## Working with a Terminal

IPmux-2L includes a V.24/RS-232 asynchronous DCE port, designated CONTROL and terminated in a 9-pin D-type female connector. The control port continuously monitors the incoming data stream and immediately responds to any input string received through this port.

The IPmux-2L control port can be configured to communicate at the following rates: 9.6, 19.2, 38.4, 57.6 or 115.2 kbps.

➤ **To start a terminal control session:**

1. Make sure all IPmux-2L cables and connectors are properly connected.
2. Connect IPmux-2L to a PC equipped with an ASCII terminal emulation application (for example, Windows Hyper Terminal or Procomm).
3. Turn on the control terminal PC and set its port parameters to 115.2 kbps, 8 bits/character, 1 stop bit, no parity. Set the terminal emulator to ANSI VT100 emulation (for optimal view of system menus).
4. When the initialization and self-test are over, a menu appears displaying initialization and self-test results.

### Login

To prevent unauthorized modification of the operating parameters, IPmux-2L supports two access levels:

- **Superuser** can perform all the activities supported by the IPmux-2L management facility, including defining new users.
- **User**'s access rights (**full control** or **read only**) are defined by the superuser. Users are not allowed to create new users.

➤ **To enter as a superuser:**

1. Enter **SU** for user name.
2. Enter **1234** for password.

This allows you to configure all the parameters of IPmux-2L, and to change the SU and user passwords.

### Choosing Options

➤ **To select a menu item:**

1. Type the corresponding line number and then press **<Enter>**.

   This will either:

   - ... display a submenu or a parameter selection screen ...

     or ...

   - ... let you type the (free text) parameter value in the same row

     or ...

   - ... toggle the current value of the corresponding parameter (relevant to **ENABLE/DISABLE** or **ON/OFF** selections).

2. When a menu does not fit on one screen (because it includes many lines), it is displayed on two consecutive pages. In this case, you will see **...(N)** after the last line on the first page and **...(P)** before the fist line on the second page:
   - While on the first page, press **N** to display the second page
   - While on the second page, press **P** to return to the first page.
3. When a configuration screen is organized as a table, a special set of keys is used for navigation within the table. The following keys may be used for navigation within tables:

   **Left Arrow** – move to the left
   **Right Arrow** – move to the right
   **Up Arrow** – scroll down
   **Down Arrow** – scroll up
4. The current value of a parameter is listed within parentheses **( )**. To change a parameter value on a parameter selection screen:
   - Type the line number corresponding to the desired value, and then press **<Enter>**
   - To enter a value which requires free text entry, type in the desired string and then press **<Enter>**. Use backspace to erase the current string.

     Note that whenever applicable, the allowed range of values of a parameter is listed within square brackets **[ ]**.
5. The entry is checked after pressing **<Enter>**, and it is accepted only if it is valid:
   - If you make an error, for example, if you press a key not active on the current screen or select an invalid parameter value, an ERROR indicator appears at the bottom. This indicator disappears as soon as you make a correct operation.
   - If you select a parameter value incompatible with the current operating state or other parameters, you will see a message that explains the error.
6. When done with the current screen, press **<Esc>** to return to the previous screen, or type **!** to return directly to the main menu.

## Ending a Terminal Configuration Session

➤ **To end the current terminal session:**

- Type **Ctrl+X**.

After a session is ended, it is necessary to enter again a valid user name and password to start a new session.

## Overview of Menu Operations

Reference the following menu trees while performing configuration and control functions. *Chapter 4* illustrates the menus and explains the parameters.

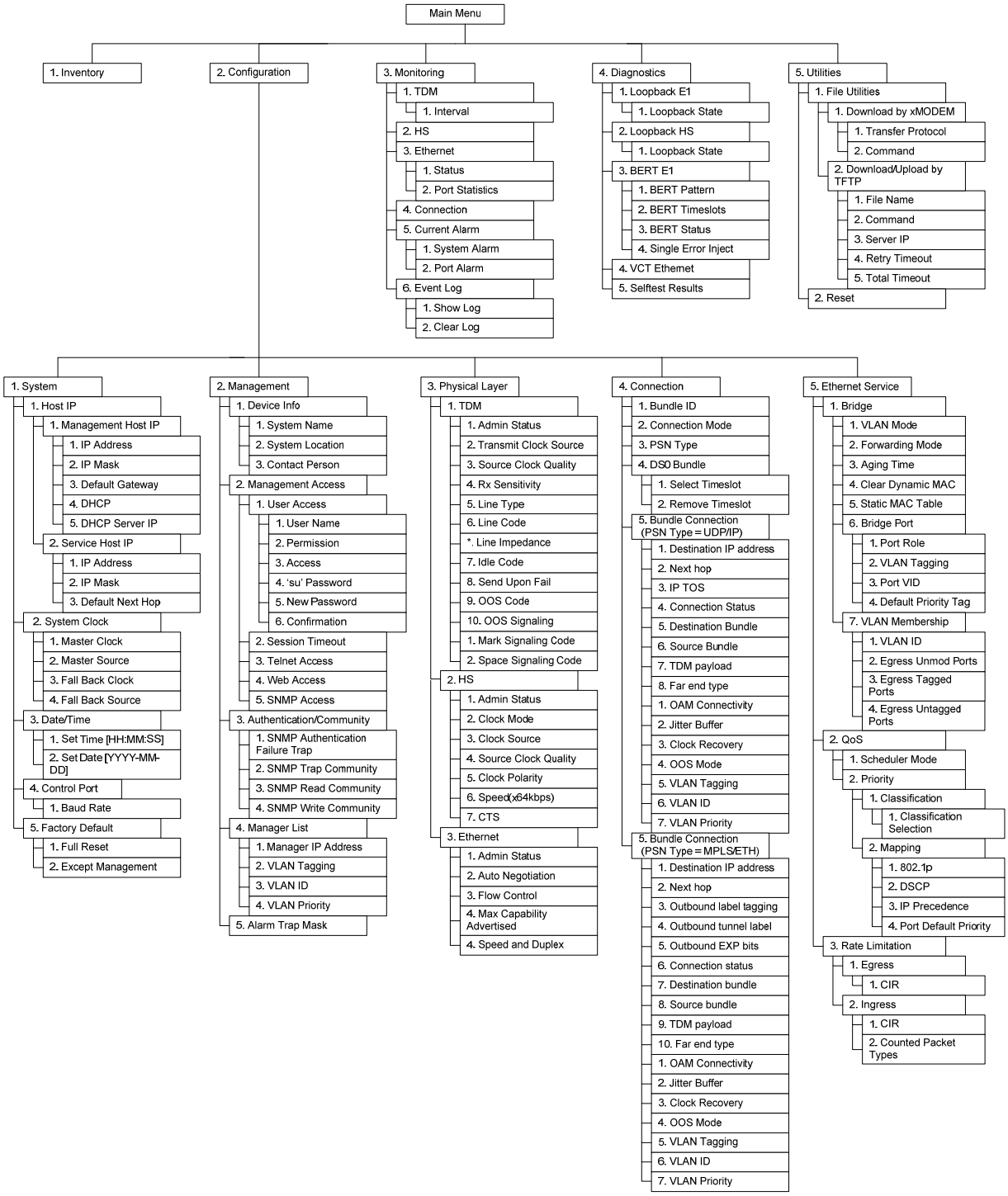


*Figure 3-4. IPmux-2L Menu Tree*

## 3.5 Turning IPmux-2L Off

➤ To power off the unit:

- Remove the power cord from the power source.

# Chapter 4

# Configuration

This chapter illustrates the configuration IPmux-2L screens and explains their parameters.

Menu trees of the IPmux-2L management software are shown in *Chapter 3*.

## 4.1 Configuring IPmux-2L for Management

Normally, management parameters are first configured with an ASCII terminal. Once the IPmux-2L host IP parameters are set, it is possible to access it via Telnet, Web terminal or RAD-EMS for operation configuration. Perform the following steps to configure IPmux-2L for management.

➤ **To perform a preliminary IPmux-2L configuration:**

1. Connect an ASCII terminal to the RS-232 control port of IPmux-2L.
2. Log in as Superuser (**SU**).
3. Enable or disable the IPmux-2L DHCP client in the Management Host IP menu.
4. Assign a service host IP address to IPmux-2L and assign a subnet mask and a default next hop to the service host
5. Assign a management host IP address to IPmux-2L and assign a subnet mask and a default gateway to the management host
6. Set read, trap, and read/write communities to public
7. Set a manager IP address and location.

***Note***

- *Make sure to save your settings at each configuration screen.*
- *Make sure to configure a valid management IP before performing TFTP operations via the Utilities› File Utilities menu.*

### Configuring Host IP Parameters

IPmux-2L can be managed by a network management station, which is located on the LAN connected to one of the unit's Ethernet ports. In order to establish a proper connection, it is necessary to configure the following: management host IP address, subnet mask, default gateway, its trap, read and write communities. In addition, you can enable or disable DHCP client of the device.

***Note***

*IPmux-2L also maintains a service host IP for PW traffic.*

## Configuring DHCP Client

To facilitate integration of a new device into a DHCP IP network, if no IP address has been manually configured, IPmux-2L automatically requests one from the DHCP server upon booting. IPmux-2L is shipped with the DHCP client set to **Enable**.

➤ **To enable DHCP client:**

1. From the Configuration->System->Host IP menu, select **Management Host IP**.

   The Management Host IP menu appears (see *Figure 4-1*).

2. Select **DHCP**, and choose **Enable**.

   IPmux-2L starts broadcasting requests for an IP address. When the DHCP server is found, IPmux-2L receives from it all necessary management host IP parameters.

***Note*** *Configuring a different service host IP address enables IPmux-2L to operate in the double IP mode. See the Managing IP Parameters of the IPmux-2L Host section below.*

```
                  RAD IPmux-2L
Management Host IP

 1. IP Address                          <192.168.99.3>
 2. IP Mask                             <255.255.255.0>
 3. Default Gateway                     <192.168.99.250>
 4. DHCP                                (Enable)
 5. DHCP Server IP                      <192.168.100.100>
 *. DHCP Status                         <DHCP_OK>

>

Please select item <1 to 5>

ESC - prev menu; ! - main menu; CTRL+X - exit; ? - help                <1 Mngr>
```

*Figure 4-1. Management Host IP Menu*

3. From this menu, you can also view the current status of the IPmux-2L DHCP client:
   - DHCP Server IP – IP address of the DHCP server
   - DHCP status – Current status of the DHCP client (DHCP_DISCOVER, DHCP_OK, DHCP disabled, etc)

## Managing IP Parameters of the IPmux-2L Host

IPmux-2L allows entering IP parameters manually or using parameters acquired from the DHCP server. IPmux-2L uses two host IP addresses:

- Management host IP for management traffic
- Service host IP for PW traffic.

***Note*** *If no service host is defined, the DS0 bundle connections are not allowed.*

They can be used in the following configurations:

- Double IP – Each host uses its own IP address
- Single IP – Management host is automatically configured to use the same IP address as the service host.

➤ **To define the management host IP parameters manually:**

1. From the Management Host IP menu (Configuration › System › Host IP › Management Host IP), disable DHCP client.
2. In the double IP configuration, perform the following:
   - Select **IP Address** to define the management host IP address. It must be different from the service host IP.
   - Select **IP Mask** to define the management host IP mask.
   - Select **Default Gateway** to set the default gateway IP address.
3. In the single IP configuration, perform the following
   - From the Service Host IP menu (Configuration › System › Host IP › Service Host IP), define a service host IP.
   - From the Management Host IP menu, perform the following:
     - Disable DHCP.
     - Configure the management host IP address to be the same as of the service host.
     - Save the setting by typing **S**.

     The subnet and next hop of the service host IP are copied to the management host and DHCP is disabled automatically.

     or

     - Disable DHCP.
     - Configure the management host IP to 0.0.0.0
     - Define a service host IP.

     IPmux-2L reboots. The subnet and next hop of the service host IP are copied to the management host and DHCP is disabled automatically.

***Note*** *The default gateway must be in the same subnet as the host.*

➤ **To acquire a new IP address from DHCP server:**

1. From the Management Host IP menu, set the designated DHCP server IP parameter or 0.0.0.0
2. Enable the DHCP client.

   IPmux-2L acquires new IP parameters from the DHCP server automatically.

## Assigning Name, Location, and Contact

The IPmux-2L management software allows you to assign a name to the unit and its location to distinguish it from the other devices installed in your system.

➤ **To assign a name , location and, the contact person:**

1. From the Device Info menu (see *Figure 4-2*), select **System Name** and enter the desired name for the IPmux-2L device.
2. Select **System Location**, and enter the desired name for the current IPmux-2L location.
3. Select **Contact Person**, and enter the desired name for the current IPmux-2L's contact person.

```
                    RAD IPmux-2L
Device Info

 1. System Name                          (System name)
 2. System Location                      (The Location of the Device)
 3. Contact Person                       (Contact person)

>

Please select item <1 to 3>

ESC - prev menu; ! - main menu; CTRL+X - exit                        <1 Mngr>
```

*Figure 4-2. Device Info Menu*

## Defining Read, Write, and Trap Communities

You must assign names for the read, write, and trap communities. In addition, you can enable sending the authentication failure trap, if a network manager from an unauthorized community attempts to access IPmux-2L.

➤ **To define read, write and trap communities:**

1. Navigate to Configuration › Management › Authentication/Community.

   The Authentication/Community menu appears (see *Figure 4-3*).
2. Select **SNMP Authentication Failure Trap** to enable or disable sending this trap in case of an unauthorized access attempt.
3. Select **SNMP Trap Community** to enter the name of a community to which IPmux-2L will send traps (up to 15 alphanumeric characters, case-sensitive).
4. Select **SNMP Read Community** to enter the name of a community with read-only authorization (up to 15 alphanumeric characters, case-sensitive).
5. Select **SNMP Write Community** to enter the name of a community with write authorization (up to 15 alphanumeric characters, case-sensitive).

```
                    RAD IPmux-2L
Authentication/Community

 1. SNMP Authentication Failure Trap    (Disable)
 2. SNMP Trap Community                 (SNMP_trap)
 3. SNMP Read Community                 (public)
 4. SNMP Write Community                (private)

>

Please select item <1 to 4>

ESC - prev menu; ! - main menu; CTRL+X - exit                          <1 Mngr>
```

*Figure 4-3. Authentication/Community Menu*

## Defining Network Managers

Define or modify the network management stations to which the SNMP agent of IPmux-2L will send traps. Up to 10 managers can be defined.

➤ To define network managers:

1. Navigate to **Configuration > Management > Manager List**.

   The Manager List menu appears (see *Figure 4-4*).

2. Type **a** to add a new manager.
3. Select **Manager IP Address**, and enter an IP address of the manager station.
4. Select **VLAN Tagging**, and choose **Enable** or **Disable** to consider or ignore the VLAN tagging of the management traffic coming from the management station.
5. Select **VLAN ID**, and enter the ID of the management station VLAN (1–4095).
6. Select **VLAN Priority**, and enter the priority of the management station VLAN (0–7).

```
                    RAD IPmux-2L
Manager List

Manager ID:1
 1. Manager IP Address                  (0.0.0.0)
 2. VLAN Tagging                        (Enable)
 3. VLAN ID[1 - 4095]                   (1)
 4. VLAN Priority[0 - 7]                (3)

>

Please select item <1 to 4>
F - Forward; A - Add; D - Delete
ESC - prev menu; ! - main menu; CTRL+X - exit                          <1 Mngr>
```

*Figure 4-4. Manager List Menu*

## Defining the Alarm Trap Mask

In addition, you can enable or disable manager stations to receive traps.

➤ **To define alarm trap mask:**

1. From the Management menu, select **Alarm Trap Mask**.

   The Management menu appears (see *Figure 4-1*).

2. Select alarms from the list. The masked alarms are neither sent to the manager, nor taken into account for alarm status and LEDs.

```
                  RAD IPmux-2L
Management

 1. Device Info                          >
 2. Management Access                    >
 3. Authentication/Community             >
 4. Manager List                         >
 5. Alarm Trap Mask                      ()

>

Please select item <1 to 5>

ESC - prev menu; ! - main menu; CTRL+X - exit                          <1 Mngr>
```

*Figure 4-5. Management Menu*

## Configuring Management Access Permissions and Methods

The user access permissions, as well as SNMP and Telnet access authorization are configured via the Management Access menu.

### Defining Management Access Permissions

IPmux-2L management software allows you to define new users, their management and access rights. Only superusers (SU) can create new users, the regular users are limited to changing their current passwords, even if they were given full management and access rights.

➤ **To add a new user:**

1. Make sure that you logged in as **SU**.
2. From the **Configuration > Management > Management Access** menu, select **User access**.

   The User Access menu is displayed (see *Figure 4-6*). From the User Access menu, do the following:

3. Select **User Name**, and enter a name for a new user.
4. Select **Permission**, and specify the user's access rights (full control or read-only).
5. Select **Access**, and specify the user's access methods (ASCII terminal, Telnet, or all of them).

***Note*** *When changing Permission and Access for an existing user, make sure to fill out the 'su' Password, New Password and Confirm fields (you can enter the current user password for the New Password and Confirm).*

6. Select **'su' Password**, and enter your current superuser password.
7. Select **New Password**, and assign a password to a new user name.
8. Select **Confirmation** and re-enter the new user password to confirm it.
9. Save new settings by typing **S**, when asked.

➤ **To delete an existing user:**

From the User Access menu, do the following:

1. Type **F** to display a user that you intend to delete.
2. Select **'su' password**, and enter your current superuser password.
3. Type **D** to delete the current user.

```
                  RAD IPmux-2L
User Access

User ID:1
 1. User Name                          (SU)
 2. Permission                         (Full control)
 3. Access                             (All)
 4. 'su' Password                      ()
 5. New Password                       ()
 6. Confirmation                       ()

>

Please select item <1 to 6>
F - Forward; A - Add; D - Delete
ESC - prev menu; ! - main menu; CTRL+X - exit                          <1 Mngr>
```

*Figure 4-6. User Access Menu*

## Controlling Management Access

You can enable or disable access to the IPmux-2L management system via an SNMP, Telnet or Web-based application. By disabling SNMP, Telnet or Web, you prevent unauthorized access to the system when security of the IPmux-2L IP address has been compromised. When SNMP, Telnet and Web access is disabled, IPmux-2L can be managed via an ASCII terminal only. In addition, you can limit access to the device to only the stations defined in the manager list. *Table 4-1* details management access implementation, depending whether the network managers are defined or not.

➤ **To define the management access method:**

1. From the Management menu, select **Management Access**.

   The Management Access menu appears (see *Figure 4-7*).

2. From the Management Access menu, select **TELNET Access** to configure Telnet access, select **SNMP Access** to configure SNMP access, or select **WEB Access** to configure Web access.
3. Define access mode for each management method:
   - Enable (Telnet, SNMP or Web access is enabled)
   - Disable (Telnet, SNMP or Web access is disabled)
   - Manager Only (Access is allowed only for the stations appearing in the manager list).

*Table 4-1. Management Access Implementation*

| **Access Method** | **Mode** | **Who is Allowed to Access IPmux-2L** | |
|---|---|---|---|
| | | **Network Manager(s) Defined** | **Network Manager(s) not Defined** |
| Telnet Access | Enable | Anybody | Anybody |
| | Disable | Nobody | Nobody |
| | Managers | Only defined network managers | Nobody |
| Web Access | Enable | Anybody | Anybody |
| | Disable | Nobody | Nobody |
| | Managers | Only defined network managers | Nobody |
| SNMP Access | Enable | Anybody | Anybody |
| | Disable | Nobody | Nobody |
| | Managers | Only defined network managers | Nobody |
| | Read Only | Anybody - Read Only | Anybody |
| | Managers Read Only | Only defined network managers - Read Only | Nobody |

```
                  RAD IPmux-2L
Management Access

 1. User Access                          >
 2. Session Timeout(sec)[180-1800]       (900)
 3. Telnet Access                        (Enable)
 4. Web access                           (Enable)
 5. SNMP Access                          (Enable)

>

Please select item <1 to 5>

ESC - prev menu; ! - main menu; CTRL+X - exit                          <1 Mngr>
```

*Figure 4-7. Management Access Menu*

## Configuring Control Port Parameters

Configuration parameters of the IPmux-2L control port, except for the baud rate are set at the factory and cannot be changed by the user (see *Figure 4-8*). These parameters have the following values:

- Data bits – 8
- Parity – None
- Stop bits – 1.

➤ To select the baud rate:

1. From the System menu, select **Control Port**.

   The Control Port menu is displayed (see *Figure 4-8*).

2. From the Control Port menu, select **Baud Rate**, and configure baud rate of the IPmux-2L terminal control port to the desired value (9600, 19200, 38400, 57600 or 115200 bps).

```
                  RAD IPmux-2L
Control Port

        Data Bits                       (8)
        Parity                          (none)
        Stop Bits                       (1)
 1. Baud Rate (bps)                     (115200)

>

Please select item <1 to 1>

ESC - prev menu; ! - main menu; CTRL+X - exit                          <1 Mngr>
```

*Figure 4-8. Control Port Menu*

## 4.2 Configuring IPmux-2L for Operation

The recommended operation configuration procedure for IPmux-2L includes the following stages:

1. Configuring the system clock
2. Assign a service host IP address (see *Configuring Host IP Parameters* in the beginning of this chapter)
3. Configuring IPmux-2L interfaces (Ethernet, E1, HS) at the physical level
4. Creating bundles by allocating timeslots to them
5. Connecting bundles by directing them to remote TDMoIP unit.

### Configuring the System Clock

You can configure the parameters of the IPmux-2L system clock including the master clock and fallback clock. If the clock type is adaptive or Rx, it is necessary to define clock source and clock quality.

***Note*** *If the configured fallback clock source fails, the internal timing is used as the fallback clock source instead.*

➤ **To configure the system clock:**

1. From the System menu, select **System Clock**.

   The System clock menu appears (see *Figure 4-9).*

2. From the System clock menu, configure the parameters listed in the following table:

*Table 4-2. System Clock Configuration*

| Parameter | Values | Description |
|---|---|---|
| Master clock | Rxclk<br>Internal<br>Adaptive | Master clock type |
| Master source | TDM Channel 1<br>TDM Channel 2<br>HS | Source of the master clock |
| Master source clock quality | Stratum 1 / PRC G.811<br>Stratum 2 / Type II G.812<br>Stratum 3 / Type IV G.812<br>Stratum 3E /Type III G.812<br>Other/Unknown | Quality of the clock source<br>***Note****: For IPmux-2L use Other/Unknown clock quality* |
| Fall back clock | Rxclk<br>Adaptive<br>None | Fallback clock to be used if the master clock fails |

| Parameter | Values | Description |
|---|---|---|
| Fall back source | TDM Channel 1<br>TDM Channel 2<br>HS | Source of the fallback clock |

```
                  RAD IPmux-2L
System clock

        Current Clock                    <Master>
 1. Master Clock                         (Rxclk)
 2. Master Source                        (TDM Channel 1)
 *. Master Source Clock Quality          <other/unknown>
 3. Fall Back Clock                      (Rxclk)
 4. Fall Back Source                     (TDM Channel 2)
 *. Fall Back Source Clock Quality       <other/unknown>

>

Please select item <1 to 4>

ESC - prev menu; ! - main menu; CTRL+X - exit                        <1 Mngr>
```

*Figure 4-9. System Clock Menu*

## Configuring the E1 Interface

The E1 interfaces of IPmux-2L are configured via the TDM menu.

➤ To configure the E1 interface:

1. Navigate to **Configuration > Physical Layer > TDM (E1)**.

   The TDM (E1) menu appears (see *Figure 4-11*).

2. Type **F** to select one of the E1 links that you intend to configure.
3. From the TDM (E1) menu, configure the E1 interface according to the following table:

*Table 4-3. E1 Interface Configuration – Page 1*

| Parameter | Values | Description |
|---|---|---|
| Admin Status | Enable | E1 link is enabled |
| | Disable | E1 link is disabled |

| Parameter | Values | Description |
|---|---|---|
| Transmit clock source | Adaptive | Adaptive clock regeneration |
| | Loopback | E1 recovered Rx clock is used as the Tx clock |
| | Internal | Tx clock is received from an internal oscillator |
| | System | System clock is used as the Tx clock |
| Source clock quality | Stratum 1<br>Stratum 2<br>Stratum 3<br>Stratum 3E<br>Other/Unknown | Quality of the clock used by the device<br>***Note**: For IPmux-2L use Other/Unknown clock quality* |
| Rx sensitivity | Short haul (-10 dB)<br>Long haul (-36 dB) | Maximum attenuation of the receive signal that can be compensated for by the interface receive path |
| Line type (E1 framing mode) | Unframed | Framing is not used |
| | Framed | G.704 framing, CRC-4 function disabled |
| | Framed CRC | G.704 framing, CRC-4 function enabled |
| | Framed MF | CAS enabled, CRC-4 function disabled |
| | Framed MF CRC | CAS enabled, CRC-4 function enabled |
| Line impedance | Balanced | 120 |
| | Unbalanced | 75 |
| Idle Code | 00 to FF | Code transmitted to fill unused timeslots in the E1 frames |

4. If you configure the Line type to Framed MF or Framed MF CRC, type **N** to display the next page of E1 parameters (*Figure 4-11*).

*Table 4-4. E1 Interface Configuration – Page 2*

| Parameter | Values | Description |
|---|---|---|
| Send Upon Fail | | Notification sent to the E1 side if Ethernet link fails |
| | OOS Code | Out-of-service code |
| | AIS | Alarm indication signal |

| Parameter | Values | Description |
|---|---|---|
| OOS code | 0–FF | Code to be sent to the E1 side if Ethernet link fails |
| OOS signaling | | Out-of-service signaling method. OOS signal is sent toward the PSN path when loss of signal, loss of frame, or AIS is detected at the E1 line. The OOS signal is also sent toward the E1 line when packet receive buffer overrun or underrun occurs |
| | Space | Code specified by the Space Signaling Code parameter is sent. Space Signaling Code: 0–f |
| | Mark | Code specified by the Mark Signaling Code parameter is sent. Mark Signaling Code: 0–f. |
| | Space Mark | Space code is sent in the first 2.5 seconds, then mark code is sent |
| | Mark Space | Mark code is sent in the first 2.5 seconds, then space code is sent |

5. Type **S** to save the changes.

```
                RAD IPmux-2L
Physical Layer

 1. TDM                                >
 2. HS                                 >
 3. Ethernet                           >

>

Please select item <1 to 3>

ESC - prev menu; ! - main menu; CTRL+X - exit                    <1 Mngr>
```

*Figure 4-10. Physical Layer Menu*

```
                  RAD IPmux-2L
Configuration/E1

                TDM Channel ID :        1
 1. Admin Status                       (Enable)
 2. Transmit Clock Source              (System)
 3. Source Clock Quality               (other/unknown)
 4. Rx Sensitivity                     (Short haul)
 5. Line Type                          (Framed MF CRC)
 6. Line Code                          (HDB3)
 *. Line Impedance                     <Balanced>
 7. Idle Code[0 - ff]                  (7e)
 8. Send Upon Fail                     (OOS code)
 9. OOS Code[0 - ff]                   (ff)
 10. OOS Signaling                     (Space)
...(N)

>

Please select item <1 to 10>
F - Forward
ESC - prev menu; ! - main menu; CTRL+X - exit                          <1 Mngr>
```

*Figure 4-11. TDM (E1) Menu (Page 1)*

```
                  RAD IPmux-2L
Configuration/E1

...(P)
 1. Mark Signaling Code[0 - f]         (d)
 2. Space Signaling Code[0 - f]        (1)

>

Please select item <1 to 2>
F - Forward
ESC - prev menu; ! - main menu; CTRL+X - exit                          <1 Mngr>
```

*Figure 4-12. TDM (E1) Menu (Page 2)*

## Configuring the Serial Interface

If IPmux-2L includes a serial interface, it must be configured at the physical layer.

➤ To configure the serial interface:

1. From the Physical Layer menu, select **HS**.

   The HS menu is displayed.

2. From the HS menu, configure the following:
   - Admin Status
     - Enable
     - Disable

- Clock Mode
  - DCE – transmits and receives clock for the user's equipment connected to the data channel are derived from the system clock, internal clock or adaptive clock.
  - DTE1 – the data channel sends the receive data accompanied by the receive clock, derived from the system clock, internal clock or adaptive clock, to the user's equipment connected to the data channel, and accepts user's data according to the user's equipment transmit clock.
  - DTE2 – transmits and receives data according to the clock signals provided by the equipment connected to the data channel. When using this clocking mode, the main link clock is locked to the clock signal supplied by the user's data channel interface. The DTE2 mode is not available on channels with X.21 interfaces.
- Clock Source
  - Adaptive
  - Internal
  - System
- Source clock quality (Quality of the clock used by the device):
  - Stratum 1
  - Stratum 2
  - Stratum 3
  - Stratum 3E
  - Other/Unknown
- Clock Polarity
  - Normal – Rising edge of the clock waveform appears in the middle of the bit interval.
  - Invert – The falling edge of the clock waveform appears in the middle of the bit interval.
    Select INVERT only when specifically instructed to do so.
- CTS (Clear-To-Send signal status)
  - On (Always ON)
  - = RTS (CTS follows RTS)

***Notes***

- *If the RTS signal failure is detected at the serial interface, IPmux-2L starts sending ff pattern in the bundles instead of user data.*
- *If a local failure is detected at the network port, IPmux-2L stops sending the DCD signal towards the device connected to its serial data port.*
- *When the CTS line is not active (CTS=OFF), the user data interface generates an all-ones signal, transmitted via the network port to the far end.*

3. Type **S** to save your changes.

```
                    RAD IPmux-2L
Configuration/HS

 1. Admin Status                          (Enable)
 2. Clock Mode                            (DCE)
 3. Clock Source                          (System)
 4. Source Clock Quality                  (other/unknown)
 5. Clock Polarity                        (Normal)
 6. Speed(x64kbps)[0-32]                  (0)
 7. CTS                                   (ON)
 *  HS Module                             <V35>
 *  RTS/Control State                     <OFF>

>

Please select item <1 to 7>

ESC - prev menu; ! - main menu; CTRL+X - exit                          <1 Mngr>
```

*Figure 4-13. HS Menu*

## Configuring Ethernet Interfaces

IPmux-2L includes three Ethernet ports, and each port can be a user or network interface.

➤ **To configure Ethernet interface:**

1. Navigate to **Configuration > Physical Layer > ETH**.

   The ETH menu appears (see *Figure 4-14*).

2. Type **F** to select the Ethernet interface that you intend to configure ( User1-Eth1 User2-Eth2 or Network-Eth3).

3. When the required Ethernet interface is displayed, configure the following:

*Table 4-5. Ethernet Interface Configuration*

| Parameter | Values | Description |
|---|---|---|
| Channel state | Enable | Current Ethernet interface is enabled |
| | Disable | Current Ethernet interface is disabled |
| Auto negotiation | Enable | Autonegotiation is enabled |
| | Disable | Autonegotiation is disabled |
| Flow Control | Enable | Flow control is enabled |
| | Disable | Flow control is disabled |
| Max capability advertised | 10BaseT Half Duplex<br>10BaseT Full Duplex<br>100BaseT Half Duplex<br>100BaseT Full Duplex | Maximum capability to be advertised during the autonegotiation process |

***Note*** *When autonegotiation protocols do not support each other, this degrades the connection to a half-duplex mode. To avoid this, disable autonegotiation and configure the ports manually. Half-duplex degradation occurs also when autonegotiation is enabled at one port and disabled at the opposite port.*

4. Type **S** to save your changes.

```
                    RAD IPmux-2L
Configuration/Ethernet

                 Port                      (Eth1/User Port)

 1. Admin Status                         (Enable)
 2. Auto Negotiation                     (Enable)
 3. Flow Control                         (Disable)
 4. Max Capability Advertised            (100M full duplex)

>

Please select item <1 to 4>
F - Forward
ESC - prev menu; ! - main menu; CTRL+X - exit                          <1 Mngr>
```

*Figure 4-14. ETH Menu*

## Configuring Bundle Connections

IPmux-2L supports up to 63 bundles (31 bundles per E1 link and 1 bundle for HS link). Each bundle can include up to 31 E1 timeslots. The bundle identification numbers can be set as 1–64.

Any bundle can be connected to any bundle of the TDMoIP device that operates opposite IPmux-2L.

➤ **To configure the bundle connection:**

1. Navigate to **Configuration** > **Connection**.

   The Connection menu appears (see *Figure 4-15*).

2. Select **Bundle ID**, and select a bundle to which you intend to assign timeslots.

3. Select **DS0 bundle**.

   The DS0 Bundle menu appears (see *Figure 4-16*).

4. From the DS0 Bundle, assign timeslots to the current bundle by selecting **Select timeslot** and choosing timeslot IDs.

   You can assign all timeslots to the current bundle at once by typing **E**.

   You can assign partial timeslots to the current bundle by typing x-y (x, y=1 to 31).

   You can cancel assignment of all timeslots to the current bundle at once by typing **L**.

5. From the Connection menu, select the connection mode:
   - **TDMoIP CE** (Time Division Multiplexing over the Internet Protocol, Circuit Emulation)
   - **SAToP** (Structure Agnostic TDM over Packet)
   - **CESoPSN without CAS** (Circuit Emulation Service over Packet Switched Network)
   - **CESoPSN with CAS**
   - **TDMoIP CE without CAS**
   - **TDMoIP CE with CAS**
   - **HDLCoPSN** (High Level Data Link Control over Packet Switched Network )
6. From the Connection menu, configure the PSN Type:
   - **UDP/IP** (Bundle encapsulation is UDP/IP)
   - **MPLS/ETH** (Bundle encapsulation is MPLS (Multi-Protocol Label Switching) /Ethernet)

***Note***

*PSN Type is only available after Bundle ID has been set.*

7. From the Connection menu, select **Bundle connection**.

   The Bundle Connection menu appears (see *Figure 4-18, Figure 4-19,* and *Figure 4-20*).

***Note***

*IPmux-2L only shows the relevant menu options, depending on the connection mode and PSN type.*

8. From the Bundle Connection menu, configure the following (if it appears in the menu):

*Table 4-6. Bundle Connection Configuration*

| Parameter | Values | Description |
|---|---|---|
| Destination IP Address | 0.0.0.0 to 255.255.255.255 | IP address of the destination device |
| Next Hop | 0.0.0.0 to 255.255.255.255 (IP) | Use the next hop parameter when the destination IP address is not in the device subnet. In such cases the Ethernet frame is sent to the next hop IP. If it is not configured, the default gateway is used. |
| IP TOS | 0–255 | IP TOS field in the IP frames transmitted by IPmux-2L. ToS configuration configures the **WHOLE** byte, since different vendors may use different bits to tag packets for traffic prioritization. ToS assignment applies to all TDM packets leaving IPmux-2L. |
| Outbound Label Tagging | Enable | MPLS Outbound labels are enabled |
| | Disable | MPLS Outbound labels are disabled |

| Parameter | Values | Description |
|---|---|---|
| Outbound tunnel label | 0–1048576 | MPLS transmit label |
| Outbound EXP bits | 0–7 | MPLS label exp bits |
| Connection Status | Enable | Connection is enabled |
| | Disable | No frames are sent on this connection |
| Destination bundle | 1–8063 | Bundle number in the destination device |
| Source bundle | 1–8063, for TDMoIP or HDLCoPSN bundles<br>1–127, for SAToP or CESoPSN bundles | Bundle number in the Source device |
| TDM Bytes in Frame (x48 bytes) | 1–30 | For TDMoIP bundle, payload length – this parameter enables reduction of Ethernet throughput |
| TDM Payload(x31 bytes) | 1–46 | For CESoPSN without CAS bundle, and its payload size is adaptive to the actual TS number in the bundle |
| TDM Payload(x30 bytes) | 1, 2, 4, 8, 16 | For CESoPSN with CAS bundle, and its payload size is adaptive to the actual TS number in the bundle |
| TDM Payload(x1 bytes) | 10-1440 | For SAToP bundle |
| Far end type | E1<br>Unframed/Serial | Type of the predefined far-end bundle |
| OAM connectivity | Enable | The device starts transmitting at full rate after it detects an active and properly configured unit on the other end of the line |
| | Disable | OAM connectivity is disabled |
| Jitter buffer | When type of the TDM interface is framed: 1.5–200 msec<br>When type of the TDM interface is unframed: 0.5–200 msec | Desired depth of the jitter (PDVT) buffer) The Packet Delay Variation Tolerance buffer absorbs network delay variation or jitter. The permitted values for Jitter buffer depth depend upon local E1/HS interface type. |
| Clock recovery | Enable<br>Disable | Choose one bundle as clock recovery source of the E1 port, set this bundle as Enable |

| Parameter | Values | Description |
|---|---|---|
| OOS Mode | | Defines whether Out of Service (OOS) signal is transmitted. The OOS signal is sent toward the IP path when loss of signal, loss of frame, or AIS is detected at the TDM line. The OOS signal is also sent toward the TDM line when packet receive buffer overrun or underrun occurs |
| | Don't Care | Don't Care OOS transmission status, and it is useful when performing E1 Internal BERT |
| | Tx OOS | OOS transmission is enabled |
| | Stop Tx | Stop transmitting the bundle data to network port when OOS occurs |
| VLAN Tagging | Enable | VLAN tagging is enabled |
| | Disable | VLAN tagging is disabled |

9. Type **S** to save the changes.

```
                  RAD IPmux-2L
Connection

 1. Bundle ID[1-64]                      (1)
 2. Connection Mode                      (TDMoIP CE)
 3. PSN Type                             (UDP/IP)
 4. DS0 Bundle                           >
>

Please select item <1 to 4>

ESC - prev menu; ! - main menu; CTRL+X - exit                          <1 Mngr>
```

*Figure 4-15. Connection Menu*

```
                  RAD IPmux-2L
DS0 bundle

        TDM Channel: 1                  Current bundle ID: 1
        +1     +2     +3     +4     +5     +6     +7     +8     +9     +10
 TS  0  NC     NC     NC     NC     NC     NC     NC     NC     NC     NC
 TS 10  NC     NC     NC     NC     NC     NC     NC     NC     NC     NC
 TS 20  NC     NC     NC     NC     NC     NC     NC     NC     NC     NC
 TS 30  NC
 1. Select Timeslot [1 - 31]            ()
 2. Remove Timeslot [1 - 31]            ()

>
Please select item <1 to 2>
F - Forward; E - Enable all
ESC - prev menu; ! - main menu; CTRL+X - exit; ? - help                <1 Mngr>
```

*Figure 4-16. DS0 Bundle Menu*

```
                  RAD IPmux-2L
Bundle Connection

        TDM Channel: 1                   Current Bundle ID: 1
        Connection Mode:                 (TDMoIP CE)
        PSN Type:                        (UDP/IP)

 1. Destination IP Address              (0.0.0.0)
 2. Next Hop                            (0.0.0.0)
 3. IP TOS[0-255]                       (0)
 4. Connection Status                   (Disable)
 5. Destination Bundle[1-8063]          (1)
 6. Source Bundle[1-8063]               (1)
 7. TDM Payload(x48 bytes)[1-30]        (1)
 8. Far End Type                        (E1)
...(N)

>

Please select item <1 to 8>
F - Forward; D - Delete
ESC - prev menu; ! - main menu; CTRL+X - exit                        <1 Mngr>
```

*Figure 4-17. Bundle Connection Menu (PSN Type=UDP/IP) (Page 1)*

```
                  RAD IPmux-2L
Bundle Connection

...(P)
 1. OAM Connectivity                    (Enable)
 2. Jitter Buffer(msec)[1.5-200]        (5.0)
 3. Clock Recovery                      (Disable)
 4. OOS Mode                            (Tx OOS)
 5. VLAN Tagging                        (Disable)

>

Please select item <1 to 5>
F - Forward; D - Delete
ESC - prev menu; ! - main menu; CTRL+X - exit                        <1 Mngr>
```

*Figure 4-18. Bundle Connection Menu (PSN Type=UDP/IP) (Page 2)*

```
                  RAD IPmux-2L
Bundle Connection

        TDM Channel: 1                   Current Bundle ID: 1
        Connection Mode:                 (TDMoIP CE)
        PSN Type:                        (MPLS/ETH)

 1. Destination IP Address              (0.0.0.0)
 2. Next Hop                            (0.0.0.0)
 3. Outbound Label Tagging              (Disable)
 4. Connection Status                   (Disable)
 5. Destination Bundle[1-8063]          (1)
 6. Source Bundle[1-8063]               (1)
 7. TDM Payload(x48 bytes)[1-30]        (1)
 8. Far End Type                        (E1)
...(N)

>

Please select item <1 to 8>
F - Forward; D - Delete
ESC - prev menu; ! - main menu; CTRL+X - exit                          <1 Mngr>
```

*Figure 4-19. Bundle Connection Menu (PSN Type=MPLS/ETH) (Page 1)*

```
                  RAD IPmux-2L
Bundle Connection

...(P)
 1. OAM Connectivity                    (Enable)
 2. Jitter Buffer(msec)[1.5-200]        (5.0)
 3. Clock Recovery                      (Disable)
 4. OOS Mode                            (Tx OOS)
 5. VLAN Tagging                        (Disable)

>

Please select item <1 to 5>
F - Forward; D - Delete
ESC - prev menu; ! - main menu; CTRL+X - exit                          <1 Mngr>
```

*Figure 4-20. Bundle Connection Menu (PSN Type=MPLS/ETH) (Page 2)*

## 4.3 Configuring the Ethernet Service

IPmux-2L contains an internal bridge connected to a TDMoIP interworking function and two external bridge ports used as the user port.

➤ **To configure Ethernet bridge:**

1. From the Configuration › Ethernet Service menu, select Bridge.

   The Bridge menu appears (*Figure 4-21*).

```
                  RAD IPmux-2L
Bridge

 1. VLAN Mode                          (Aware)
 2. Forwarding Mode                    (Filter)
 3. Aging Time (sec) [0...3825]        (300)
 4. Clear Dynamic MAC
 5. Static MAC Table [ ]               >
 6. Bridge Port                        >
 7. VLAN Membership                    >

>

Please select item <1 to 7>

ESC - prev menu; ! - main menu; CTRL+X - exit                        <1 Mngr>
```

*Figure 4-21. Bridge Menu*

2. From the Bridge menu, select **Aging time** and define a period of time in seconds from the moment when a node is disconnected from the network segment or becomes inactive and removal of the node address from the database.
3. Select **Clear Dynamic MAC**, if you intend to delete all learned addresses from the MAC table.
4. Select **Bridge Port**, and the Bridge Port menu appears:

```
                  RAD IPmux-2L
Bridge Port

               Port                    (Eth1/User Port)

 1. Port Role                          (User Port)
 2. VLAN Tagging                       (Transparent)
 3. Port VID [1 - 4094]                (1)
 4. Default Priority Tag [0 - 7]       (5)

>

Please select item <1 to 4>
F - Forward
ESC - prev menu; ! - main menu; CTRL+X - exit; ? - help              <1 Mngr>
```

*Figure 4-22. Bridge Port Menu*

5. Define the following:
   - Port Role
     - User Port
     - Network Port

- VLAN tagging (Operation mode for the corresponding port of internal switch)
  - Transparent
  - Tag (Tagged)
  - Untag (Untagged)
  - DoubleTag (Double Tagged)
- Port VID: 1–4094
- Default Priority Tag: 0–7

***Notes***

*In order to guarantee QoS, the default priority tag for all user ports must be less than default priority tag of the network port.*

6. From the Bridge menu, select **VLAN Membership**, and *Figure 4-23* displays:

```
                  RAD IPmux-2L
VLAN Membership

 Eth1  VLANs >(    1,   2                                )
 Eth2  VLANs >(    1,   2                                )
 Eth3  VLANs >(    1,   2                                )


 1. VLAN ID[1 - 4094]                  (1)
 2. Egress Unmod Ports                 (Eth1  / Eth2  / Eth3)
 3. Egress Tagged Ports                (None)
 4. Egress Untagged Ports              (None)

*Total 2 VLANs
>

Please select item <1 to 4>
F - Forward; A - Add; R-Remove; N-Next
ESC - prev menu; ! - main menu; CTRL+X - exit; ? - help                <1 Mngr>
```

*Figure 4-23. VLAN Membership Menu*

7. Configure the following:
   - VLAN ID (Specifies VLAN, which the current bridge port will be a member of): 1–4094
   - Egress Unmod Ports
     - None
     - Eth1
     - Eth2
     - Eth3
     - Eth1 / Eth2
     - Eth1 / Eth3
     - Eth2 / Eth3
     - Eth1 / Eth2 / Eth3

- Egress Tagged Ports
  - None
  - Eth1
  - Eth2
  - Eth3
  - Eth1 / Eth2
  - Eth1 / Eth3
  - Eth2 / Eth3
  - Eth1 / Eth2 / Eth3
- Egress Untagged Ports
  - None
  - Eth1
  - Eth2
  - Eth3
  - Eth1 / Eth2
  - Eth1 / Eth3
  - Eth2 / Eth3
  - Eth1 / Eth2 / Eth3

➤ **To configure QoS:**

1. From the **Configuration** > **Ethernet Service** menu, select **QoS**.

   The QoS menu appears:

```
                  RAD IPmux-2L
QoS

 1. Scheduler Mode                      (Strict Priority)
 2. Priority                            >
 3. Rate Limitation                     >
>
Please select item <1 to 3>
ESC - prev menu; ! - main menu; CTRL+X - exit                          <1 Mngr>
```

*Figure 4-24. QoS Menu*

2. From the QoS menu, select **Scheduler Mode** and choose:
   - Strict Priority (All top priority frames egress until the priority queue is empty. Then the next lower priority queue frames egress, etc. The strict scheme can cause the lower priorities to be starved out preventing them from transmitting any frames, but also ensures that all high priority frames egress the switch as soon as possible.)
   - Weighted (All frames are round-robin scheduled according to an 8-4-2-1 weighting for the Traffic Class queue 3, Traffic Class queue 2, Traffic Class queue 1, and Traffic Class queue 0. It prevents the lower priority frames from being starved out with only a slight delay to the higher priority frames.)

3. Select **Priority**, select **Classification** from the following types, and you can select **Mapping** to define the User Priority of each type:
   - 802.1p
   - DSCP
   - IP Precedence
   - Port Default Priority
4. Select **Rate Limitation**:
   - Select **Egress** and define the rate limiting ranges for the egress traffic.
   - Select **Ingress** and define the rate limiting ranges for the ingress traffic. The actual data rate of the incoming traffic is selected from the rates.

## 4.4 Additional Tasks

This section describes additional operations available supported by the IPmux-2L management software, including the following:

- Displaying inventory
- Setting data and time
- Displaying IPmux-2L status
- Transferring software and configuration files
- Resetting the unit.

### Displaying the IPmux-2L Inventory

The IPmux-2L inventory displays information on current software and hardware revisions of the unit. It also provides the IPmux-2L interface description.

➤ **To display the IPmux-2L inventory:**

- From the Main menu, select **Inventory**.

```
                    RAD IPmux-2L
Inventory

Hardware
        Version(PCB/CPLD)                       (1.2/1.06)
        RAM Size                                (2MB)
        Box Type                                (PLASTIC)
        MAC Address                             (00-20-D2-2A-85-F4)

Software
        Boot Version:                           (1.02    2008-02-18 15:54:00)
        Application Version                     (1.10    2008-03-31 20:20:00)
        Backup Version                          (1.10    2008-03-31 20:20:00)

...(N)

>

ESC - prev menu; ! - main menu; CTRL+X - exit                          <1 Mngr>
```

*Figure 4-25. Inventory Screen (Page 1)*

```
                    RAD IPmux-2L
Inventory

...(P)

Interfaces
        TDM1                                    (E1 over UTP)
        TDM2                                    (E1 over UTP)
        HS                                      (DB25-based RS530)
        ETH1/User                               (Copper/UTP/RJ-45)
        ETH2/User                               (Copper/UTP/RJ-45)
        ETH3/Net                                (Optical 1310nm SM IR-1 LC)
                                                (P/N:RTXM139-401)

>

ESC - prev menu; ! - main menu; CTRL+X - exit                          <1 Mngr>
```

*Figure 4-26. Inventory Screen (Page 2)*

## Setting the Date and Time

You can set the date and time for the IPmux-2L internal real-time clock.

➤ To set date and time:

1. Navigate to **Configuration** > **System** > **Date/Time** .

   The General menu appears (see *Figure 4-27*).

2. Select **Set time**, and enter the current time in the hh:mm:ss format.
3. Select **Set date**, and enter the current date in the yyyy:mm:dd format.

```
                  RAD IPmux-2L
Date/Time

        System Up Time                    <0 days 02:24:22>

 1. Set Time [HH:MM:SS]                   <02:24:25>
 2. Set Date [YYYY-MM-DD]                 <2008-01-01>

>

Please select item <1 to 2>

ESC - prev menu; ! - main menu; CTRL+X - exit                        <1 Mngr>
```

*Figure 4-27. Date/Time Menu*

## Displaying the Bundle Connection Information

You can display information on the current bundle connection, its connectivity status, collected sequence errors, and statistics for underflows and overflows of the jitter buffer (see *Chapter 6* for details on the bundle statistics).

➤ **To display the bundle connection information:**

1. From the Status menu, select Connection.

   The Connection screen is displayed (see *Figure 4-28*).

2. Select **Bundle ID** and enter the number of the bundle whose status you wish to display.

   The Bundle Status screen contains the following information:

*Table 4-7. Connectivity Status*

| Status | Values | Description |
|---|---|---|
| Bundle Status | Disabled | No activity in the channel. The bundle is disabled. |
| | Down | The bundle does not transmit and receive Ethernet any frame |
| | Connected | Both the remote and the local IPmux-2L bundle receive Ethernet frames. However, there may be problems such as sequence errors, underflows, overflows, as explained below. |
| | Local Fail | The local IPmux-2L bundle does not receive Ethernet frames |
| | Remote Fail | The remote IPmux-2L bundle does not receive Ethernet frames |
| | Unavailable | The remote IPmux-2L bundle does not reply to OAM messages (only applicable when OAM is enabled) |
| | Validation Fail | The remote IPmux-2L bundle replies, but there is a configuration error (only applicable when OAM is enabled |

| Status | Values | Description |
|---|---|---|
| | TDM Fail | There is LOS/LOF/AIS at the TDM side |
| | BuffOverThreshExc | Both the remote and the local IPmux-2L bundle receive Ethernet frames, but Jitter buffer overflows threshold exceeded |
| | BuffUnderThreshExc | Both the remote and the local IPmux-2L bundle receive Ethernet frames, but Jitter buffer underflows threshold exceeded |
| | SeqErrThreshExc | Both the remote and the local IPmux-2L bundle receive Ethernet frames, but sequence errors threshold exceeded |
| | ***Note**: When the bundle connection status is Disabled, Local Fail or Remote Fail, the connection counters are disabled.* | |
| OAM Status | Disabled | No activity bundle in the channel. OAM Connectivity is disabled |
| | Out of Synchronization | OAM is out of synchronization |
| | Synchronized | Both the remote and the local IPmux-2L bundle receive Ethernet frames.OAM is connected |
| | Validation Failed | The remote IPmux-2L bundle replies, but there is a configuration error |
| Sequence errors | | Total number of sequence errors occurred on the bundle |
| Jitter buffer underflows | | Total number of jitter buffer underflows occurred on the bundle |
| Jitter buffer overflows | | Total number of jitter buffer overflows occurred on the bundle |
| Max Jitter buffer deviation | | The maximum jitter buffer deviation (msec) in the interval (900 sec) on the bundle. |
| Min Jitter buffer level | | The minimum jitter buffer level for the current bundle |
| Max Jitter buffer level | | The maximum jitter buffer level for the current bundle |

```
                  RAD IPmux-2L
Statistics/Connection

Bundle Status/OAM Status (Connected/Synchronized)

 Sequence errors:                     ...(0)
 Jitter buffer underflows:            ...(188)
 Jitter buffer overflows:             ...(0)
 Max Jitter buffer deviation [msec]:  ...(5)
 Min Jitter buffer level [msec]:      ...(0)
 Max Jitter buffer level [msec]:      ...(0)
 Total rx frames:                     ...(0)
 Total tx frames:                     ...(886622)
 Time since    (189)      Valid intervals    (1~96)
 1. Bundle ID[1-64]                     (1)
 2. Interval                            (0)

>

Please select item <1 to 2>
F - Forward
ESC - prev menu; ! - main menu; CTRL+X - exit; C-Clear                <1 Mngr>
```

*Figure 4-28. Connection Screen*

## Transferring Software and Configuration Files

Software and configuration files can be transferred by Xmodem, Ymodem or TFTP. Once the downloading and the file CRC check are completed, IPmux-2L saves the new release as an active partition, the former active partition turns into backup, and the IPmux-2L boots up automatically.

➤ To transfer a file by xMODEM:

1. From the **Utilities > File Utilities** menu, select **Download by xMODEM**.
2. From the Download by xMODEM menu, configure the following:
   - Transfer Protocol (Xmodem or Ymodem)
   - Command (Operation type)
     - Software download
     - Configuration download
3. Select the file.

   IPmux-2L starts file transfer by Xmodem, Ymodem.

```
                    RAD IPmux-2L
Download by xMODEM

 1. Transfer Protocol                    (Xmodem)
 2. Command                              (Software download)
 *  Transfer Status                      <No operation>

>

Please select item <1 to 2>

ESC - prev menu; ! - main menu; CTRL+X - exit                          <1 Mngr>
```

*Figure 4-29. Download by xMODEM*

➤ To transfer a file by TFTP:

1. From the File Utilities menu, select Download/Upload by TFTP.
2. From the Download/Upload by TFTP menu, configure the following:
   - File Name (Name of the file that you intend to transfer)
   - Command (Operation type)
     - Software download
     - Configuration download
     - Configuration upload
     - Software upload
   - Server IP (IP address of the TFTP server)
   - Retry Timeout (Interval between connection retries in seconds)
   - Total Timeout (TFTP connection timeout in seconds)
   - View Transfer Status (Current status of the TFTP transfer)
3. Save the changes.

   IPmux-2L starts file transfer using TFTP.

```
                    RAD IPmux-2L
Download/Upload by TFTP

 1. File Name                            (null.dat)
 2. Command                              (Configuration upload)
 3. Server IP                            (0.0.0.0)
 4. Retry Timeout(sec)[1 - 1000]         (1)
 5. Total Timeout(sec)[1 - 1000]         (5)
 *  Transfer Status                      <No operation>

>

Please select item <1 to 5>
CTRL+C - Cancel
ESC - prev menu; ! - main menu; CTRL+X - exit                          <1 Mngr>
```

*Figure 4-30. Download/Upload by TFTP Menu*

## Resetting IPmux-2L

IPmux-2L supports two types of reset:

- Reset to the default setting
  - Resetting all parameters
  - Resetting all parameters, except for management values
- Overall reset of the device.

### Resetting IPmux-2L to the Defaults

You can reset IPmux-2L to its default settings. The reset to the defaults does not affect the master clock setting. In addition, you can reset local IPmux-2L without affecting its management parameters (IP address, mask and default gateway).

➤ **To reset IPmux-2L to the default settings:**

1. From the System menu, select **Factory default**.
2. From the Factory Default menu, perform one the following steps:
   - Select **Full Reset** to reset all IPmux-2L parameters to the default settings.

     IPmux-2L displays the following message:
     **`Do you want to reset all configurations and reboot (Y/N)?`**
   - Select **Except Management** to reset all parameters, except for IP address, mask and default gateway values.

     IPmux-2L displays the following message:
     **`Do you want to reset service configuration and reboot (Y/N)?`**
3. Type **Y** to confirm the reset.

   IPmux-2L performs the requested type of reset.

### Performing the Overall Reset

You can perform the overall reset of IPmux-2L.

➤ **To reset IPmux-2L:**

1. From the Main menu, select **Utilities**.

   The Utilities menu appears (see *Figure 4-31*).
2. From the Utilities menu, select **Reset**.

   A confirmation message appears.
3. Type **Y** to confirm the reset.

```
                  RAD IPmux-2L
Utilities

 1. File Utilities                      >
 2. Reset
>
Please select item <1 to 2>
ESC - prev menu; ! - main menu; CTRL+X - exit                          <1 Mngr>
```

*Figure 4-31. Utilities Menu*

# Chapter 5

# Configuring a Typical Application

This chapter provides detailed instructions for setting up a typical application using three IPmux-2L units.

## 5.1 Overview

### Application

The section provides detailed instructions for configuring one IPmux-2L unit operating opposite two IPmux-2L units (see *Figure 5-1*).

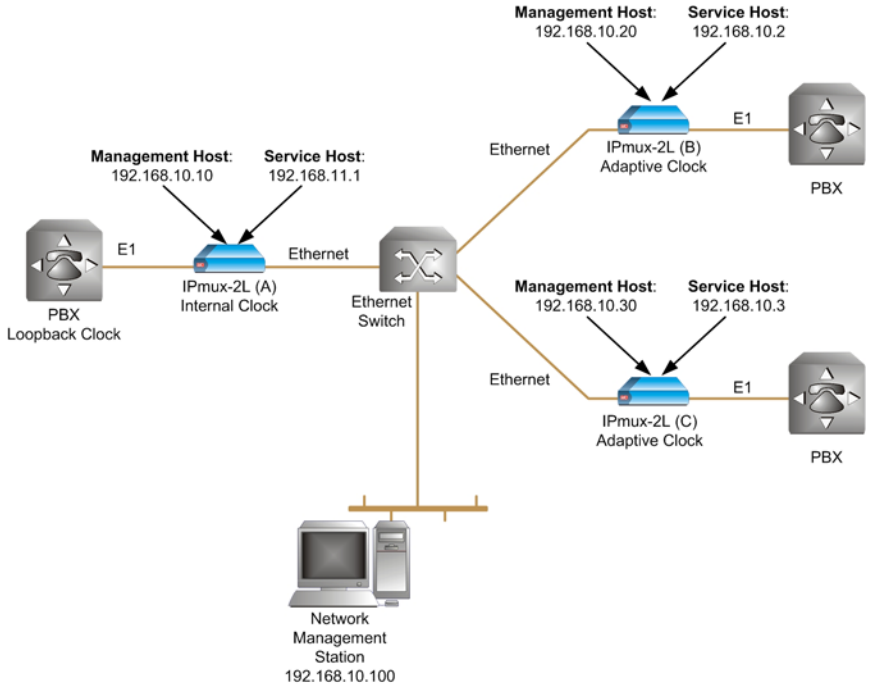


*Figure 5-1. One IPmux-2L Unit Working Opposite Two IPmux-2L Units*

### Guidelines for Configuring the IPmux-2L Units

There are four basic configuration steps (described below) that need to be followed when deploying any IPmux-2L unit.

1. IP configuration – Setting the device host IP address including the management host IP address and the Service Host IP.
2. Physical layer configuration – Setting the E1 or HS parameters (line type, clocking, etc.) according to the application requirements and topology.
3. Creating bundles – Allocating timeslots to bundles
4. Connecting bundles – Directing the bundles, defined above, to remote IPmux-2L units.

*Table 5-1. Configuration Summary*

| Device | E1 Parameters | IP Parameters | Bundle Parameters | Bundle Connection |
|---|---|---|---|---|
| IPmux-2L (A) | Transmit clock source: Internal<br>Line type: Framed CRC | Management host IP address: 192.168.10.10<br>Service host IP address: 192.168.10.1 | Bundle 1 Timeslots in bundle: 1–10<br>Bundle 2 Timeslots in bundle: 11–20 | Bundle 1 of IPmux-2L (B)<br>Bundle 1 of IPmux-2L (C) |
| IPmux-2L (B) | Transmit clock source: adaptive<br>Line type: Framed CRC | Management host IP address: 192.168.10.20<br>Service host IP address: 192.168.10.2 | Bundle 1 Timeslots in bundle: 1–10 | Bundle 1 of IPmux-2L (A) |
| IPmux-2L (C) | Transmit clock source: adaptive<br>Line type: Framed CRC | Management host IP address: 192.168.10. 30<br>Service host IP address: 192.168.10. 3 | Bundle 1 Timeslots in bundle: 1–10 | Bundle 2 of IPmux-2L (A) |

## 5.2 Configuring the IPmux-2L (A) Unit

This section explains how to configure the IPmux-2L unit. Refer to *Chapter 3* for explanation of how to select management options and save the changes.

### Configuring the IP Parameters

➤ **To configure the management host IP parameters:**

1. Display the Management Host IP menu (**Configuration** › **System** › **Host IP** › **Management Host IP**), and configure the IP address and mask of the device.
2. Disable the DHCP mechanism
3. Save the changes
4. Set the IP address – 192.168.10.10
5. Set the IP mask – 255.255.255.0
6. Save the changes.

```
                  RAD IPmux-2L
Management Host IP

 1. IP Address                          (192.168.10.10)
 2. IP Mask                             (255.255.255.0)
 3. Default Gateway                     (0.0.0.0)
 4. DHCP                                (Disable)
 5. DHCP Server IP                      (0.0.0.0)
 *. DHCP Status                         <DHCP disabled>

>

Please select item <1 to 5>

ESC - prev menu; ! - main menu; CTRL+X - exit; ? - help              <1 Mngr>
```

*Figure 5-2. Configuring Management Host IP Parameters for IPmux-2L (A)*

➤ To configure the service host IP address:

1. Display the Service Host IP menu (Configuration › System › Host IP › Service Host IP), and enter following parameters for the Service:
   - IP address – 192.168.10.1
   - IP mask – 255.255.255.0
2. Save the changes.

```
                  RAD IPmux-2L
Service Host IP

 1. IP Address                          (192.168.10.1)
 2. IP Mask                             (255.255.255.0)
 3. Default Next Hop                    (0.0.0.0)

>

Please select item <1 to 3>

ESC - prev menu; ! - main menu; CTRL+X - exit                        <1 Mngr>
```

*Figure 5-3. Configuring Service Host IP Parameters for IPmux-2L (A)*

➤ To configure the manager list:

1. Display the Manager List menu (Configuration › System › Management › Manager List), and enter IP parameters for the network manager station:
   - Manager IP address – 192.168.10.100
2. Save the changes.

```
                  RAD IPmux-2L
Manager List

Manager ID:1
 1. Manager IP Address                  (192.168.10.100)
 2. VLAN Tagging                        (Disable)


>

Please select item <1 to 2>
F - Forward; A - Add; D - Delete
ESC - prev menu; ! - main menu; CTRL+X - exit                          <1 Mngr>
```

*Figure 5-4. Configuring Network Manager*

## Configuring E1 Parameters at the Physical Layer

➤ To configure E1 parameters at the physical layer:

- Display the TDM Configuration Menu (**Configuration > Physical Layer > TDM**) and configure the following parameters:
  - Channel ID – 1
  - Transmit clock source – Internal
  - Line type – Framed CRC

```
                  RAD IPmux-2L
Configuration/E1

         TDM Channel ID :  1
 1. Admin Status                        (Enable)
 2. Transmit Clock Source               (Internal)
 3. Source Clock Quality                (other/unknown)
 4. Rx Sensitivity                      (Short haul)
 5. Line Type                           (Framed CRC)
 6. Line Code                           (HDB3)
 *. Line Impedance                      <Balanced>
 7. Idle Code[0 - ff]                   (7e)
 8. Send Upon Fail                      (OOS code)
 9. OOS Code[0 - ff]                    (ff)

>

Please select item <1 to 9>
F - Forward
ESC - prev menu; ! - main menu; CTRL+X - exit                          <1 Mngr>
```

*Figure 5-5. Configuring at the Physical Level for IPmux-2L*

## Configuring Bundles

➤ To assign timeslots to bundles:

1. Display the Connection menu (**Configuration** > **Connection**), and assign number 1 to a bundle.
2. Display the DS0 Bundle Configuration menu (**Configuration** > **Connection** > **DS0 bundle**), and assign timeslots 1 to 10 to bundle 1.
3. Back off to the **Connection** menu and assign number 2 to a bundle.
4. Display the DS0 Bundle menu and assign timeslots 11 to 20 to bundle 2.

```
                    RAD IPmux-2L
DS0 bundle

        TDM Channel: 1                  Current bundle ID: 2
        +1     +2     +3     +4     +5     +6     +7     +8     +9     +10
 TS  0   1      1      1      1      1      1      1      1      1      1
 TS 10   2      2      2      2      2      2      2      2      2      2
 TS 20  NC     NC     NC     NC     NC     NC     NC     NC     NC     NC
 TS 30  NC

 1. Select Timeslot [1 - 31]            ()
 2. Remove Timeslot [1 - 31]            ()

>

Please select item <1 to 2>
F - Forward
ESC - prev menu; ! - main menu; CTRL+X - exit; ? - help                <1 Mngr>
```

*Figure 5-6. Assigning Timeslots to Bundle 1 and Bundle 2*

➤ To connect bundle 1:

1. Display the Bundle Connection Configuration menu for bundle 1 (**Configuration** > **Connection** > **Bundle connection**) and configure the following parameters:
   - Destination IP – 192.168.10.2
   - Jitter buffer –5.0(msec)
   - OAM Enable
2. Leave all other parameters with their default values.
3. Set the connection status to Enable.
4. Save the changes.

```
                  RAD IPmux-2L
Bundle Connection

        TDM Channel: 1                   Current Bundle ID: 1
        Connection Mode:                 (TDMoIP CE)
        PSN Type:                        (UDP/IP)

 1. Destination IP Address              (192.168.10.2)
 2. Next Hop                            (0.0.0.0)
 3. IP TOS[0-255]                       (0)
 4. Connection Status                   (Enable)
 5. Destination Bundle[1-8063]          (1)
 6. Source Bundle[1-8063]               (1)
 7. TDM Payload(x48 bytes)[1-30]        (1)
 8. Far End Type                        (E1)
...(N)

>

Please select item <1 to 8>
F - Forward; D - Delete
ESC - prev menu; ! - main menu; CTRL+X - exit                          <1 Mngr>
```

*Figure 5-7. Connecting Bundle 1 for IPmux-2L (A)*

```
                  RAD IPmux-2L
Bundle Connection

...(P)
 1. OAM Connectivity                    (Enable)
 2. Jitter Buffer(msec)[1.5-125]        (5.0)
 3. Clock Recovery                      (Disable)
 4. OOS Mode                            (Tx OOS)
 5. VLAN Tagging                        (Disable)

>
Please select item <1 to 5>
F - Forward; D - Delete
ESC - prev menu; ! - main menu; CTRL+X - exit                          <1 Mngr>
```

*Figure 5-8. Connecting Bundle 1 for IPmux-2L (A) (Page 2)*

➤ To connect bundle 2:

1. Display the Bundle Connection menu for bundle 2 (**Configuration** › **Connection** › **Bundle connection**) and configure the following parameters:
   - Destination IP – 192.168.10.3
   - Jitter buffer –5.0 (msec)
   - OAM Enable
2. Leave all other parameters with their default values.
3. Set the connection status to Enable.
4. Save the changes.

```
                  RAD IPmux-2L
Bundle Connection

        TDM Channel: 1                   Current Bundle ID: 2
        Connection Mode:                 (TDMoIP CE)
        PSN Type:                        (UDP/IP)

 1. Destination IP Address              (192.168.10.3)
 2. Next Hop                            (0.0.0.0)
 3. IP TOS[0-255]                       (0)
 4. Connection Status                   (Enable)
 5. Destination Bundle[1-8063]          (2)
 6. Source Bundle[1-8063]               (2)
 7. TDM Payload(x48 bytes)[1-30]        (1)
 8. Far End Type                        (E1)
...(N)

>

Please select item <1 to 8>
F - Forward; D - Delete
ESC - prev menu; ! - main menu; CTRL+X - exit                          <1 Mngr>
```

*Figure 5-9. Connecting Bundle 2 for IPmux-2L (A)*

```
                  RAD IPmux-2L
Bundle Connection

...(P)
 1. OAM Connectivity                    (Enable)
 2. Jitter Buffer(msec)[1.5-125]        (5.0)
 3. Clock Recovery                      (Disable)
 4. OOS Mode                            (Tx OOS)
 5. VLAN Tagging                        (Disable)

>

Please select item <1 to 5>
F - Forward; D - Delete
ESC - prev menu; ! - main menu; CTRL+X - exit                          <1 Mngr>
```

*Figure 5-10. Connecting Bundle 2 for IPmux-2L (A) (Page 2)*

## 5.3 Configuring the IPmux-2L (B)/(C) Units

This section explains how to configure IPmux-2L (B)/(C) units. The configuration procedure is similar for both units, except for defining different host IP addresses and different destination IP address for the bundle connection. Refer to *Chapter 3* for explanation of how to select management options and save the changes.

## Configuring the IP Parameters

➤ To configure the management host IP parameters:

1. Display the Management Host IP menu (**Configuration** › **System** › **Host IP** › **Management Host IP**), and configure the IP address and mask of the host.
2. Disable the DHCP mechanism
3. Save the changes
4. Set the IPmux-2L (B) IP address – 192.168.10.20
5. Set the IPmux-2L (C) IP address – 192.168.10.30
6. Set the IP mask – 255.255.255.0
7. Save the changes.

```
                  RAD IPmux-2L
Management Host IP

 1. IP address                          (192.168.10.20)
 2. IP mask                             (255.255.255.0)
 3. Default gateway                     (0.0.0.0)
 4. DHCP                                (Disable)
 5. DHCP Server IP                      (0.0.0.0)
 *. DHCP Status                         <DHCP disabled>

>

Please select item <1 to 5>

ESC - prev menu; ! - main menu; CTRL+X - exit; ? - help              <1 Mngr>
```

*Figure 5-11. Configuring Host IP Parameters for IPmux-2L (B)*

➤ To configure the service host IP address:

1. Display the Service Host IP menu (**Configuration** › **System** › **Host IP** › **Service Host IP**), and enter following parameters for the Service:
   - IPmux-2L (B) IP address – 192.168.10.2
   - IPmux-2L (C) IP address – 192.168.10.3
   - IP mask – 255.255.255.0
2. Save the changes.

```
                  RAD IPmux-2L
Service Host IP

 1. IP address                          (192.168.10.2)
 2. IP mask                             (255.255.255.0)
 3. Default next hop                    (0.0.0.0)

>

Please select item <1 to 3>

ESC - prev menu; ! - main menu; CTRL+X - exit                          <1 Mngr>
```

*Figure 5-12. Configuring Network Manager*

➤ To configure the manager list:

1. Display the Manager List menu (Configuration › System › Management › Manager List), and enter IP parameters for the network manager station:
   - Manager IP address – 192.168.10.100
2. Save the changes.

```
                  RAD IPmux-2L
Manager List

Manager ID:1
 1. Manager IP Address                  (192.168.10.100)
 2. VLAN Tagging                        (Disable)


>

Please select item <1 to 2>
F - Forward; A - Add; D - Delete
ESC - prev menu; ! - main menu; CTRL+X - exit                          <1 Mngr>
```

*Figure 5-13. Configuring Network Manager*

## Configuring E1 Parameters at the Physical Layer

➤ To configure E1 parameters at the physical layer:

- Display the TDM Configuration Menu (Configuration › Physical Layer › TDM) and configure the following parameters:
  - Channel ID – 1
  - Line type – Framed CRC

```
                  RAD IPmux-2L
Configuration/E1

         TDM Channel ID :  1
 1. Admin Status                        (Enable)
 2. Transmit Clock Source               (System)
 3. Source Clock Quality                (other/unknown)
 4. Rx Sensitivity                      (Short haul)
 5. Line Type                           (Framed CRC)
 6. Line Code                           (HDB3)
 *. Line Impedance                      <Balanced>
 7. Idle Code[0 - ff]                   (7e)
 8. Send Upon Fail                      (OOS code)
 9. OOS Code[0 - ff]                    (ff)

>

Please select item <1 to 9>
F - Forward
ESC - prev menu; ! - main menu; CTRL+X - exit                        <1 Mngr>
```

*Figure 5-14. Configuring at the Physical Level for IPmux-2L (B)/(C)*

## Configuring Bundles

➤ To assign timeslots to a bundle:

1. Display the Connection menu (**Configuration** › **Connection**), and assign number 1 to a bundle.
2. Display the DS0 Bundle Configuration menu (**Configuration** › **Connection** › **DS0 bundle**), and assign timeslots 1 to 10 to bundle 1.

```
                  RAD IPmux-2L
DS0 bundle

        TDM Channel: 1                  Current bundle ID: 1
        +1     +2     +3     +4     +5     +6     +7     +8     +9     +10
 TS  0   1      1      1      1      1      1      1      1      1      1
 TS 10  NC     NC     NC     NC     NC     NC     NC     NC     NC     NC
 TS 20  NC     NC     NC     NC     NC     NC     NC     NC     NC     NC
 TS 30  NC

 1. Select Timeslot [1 - 31]            ()
 2. Remove Timeslot [1 - 31]            ()

>

Please select item <1 to 2>
F - Forward; E - Enable all; L - Disable all
ESC - prev menu; ! - main menu; CTRL+X - exit; ? - help              <1 Mngr>
```

*Figure 5-15. Assigning Timeslots to Bundle 1*

➤ To connect the bundles:

1. Display the Bundle Connection Configuration menu (**Configuration** › **Connection** › **Bundle connection**) and configure the following parameters:
   - Destination IP address for IPmux-2L (B) bundle – 192.168.10.1
   - Destination IP address for IPmux-2L (C) bundle – 192.168.10.1
   - Jitter buffer – 5.0 (msec)
   - Clock Recovery – Enable
   - OAM Enable
2. Leave all other parameters with their default values.
3. Set the connection status to Enable.
4. Save the changes.

```
                    RAD IPmux-2L
Bundle Connection

        TDM Channel: 1                    Current Bundle ID: 1
        Connection Mode:                  (TDMoIP CE)
        PSN Type:                         (UDP/IP)

 1. Destination IP Address               (192.168.10.1)
 2. Next Hop                             (0.0.0.0)
 3. IP TOS[0-255]                        (0)
 4. Connection Status                    (Enable)
 5. Destination Bundle[1-8063]           (1)
 6. Source Bundle[1-8063]                (1)
 7. TDM Payload(x48 bytes)[1-30]         (1)
 8. Far End Type                         (E1)
...(N)

>

Please select item <1 to 8>
F - Forward; D - Delete
ESC - prev menu; ! - main menu; CTRL+X - exit                          <1 Mngr>
```

*Figure 5-16. Connecting Bundle for IPmux-2L (B)/(C) (Page 1)*

```
                  RAD IPmux-2L
Bundle Connection

...(P)
 1. OAM Connectivity                    (Enable)
 2. Jitter Buffer(msec)[1.5-200]        (5.0)
 3. Clock Recovery                      (Enable)
 4. OOS Mode                            (Tx OOS)
 5. VLAN Tagging                        (Disable)

>

Please select item <1 to 5>
F - Forward; D - Delete
ESC - prev menu; ! - main menu; CTRL+X - exit                          <1 Mngr>
```

*Figure 5-17. Connecting Bundle for IPmux-2L (B)/(C) (Page 2)*

➤ To configure E1 transmit clock source:

- Display the TDM Configuration Menu (**Configuration > Physical Layer > TDM**) and configure the following parameters:
  - Transmit Clock Source – Adaptive

```
                  RAD IPmux-2L
Configuration/E1

         TDM Channel ID :  1
 1. Admin Status                        (Enable)
 2. Transmit Clock Source               (Adaptive)
 3. Source Clock Quality                (other/unknown)
 4. Rx Sensitivity                      (Short haul)
 5. Line Type                           (Framed CRC)
 6. Line Code                           (HDB3)
 *. Line Impedance                      <Balanced>
 7. Idle Code[0 - ff]                   (7e)
 8. Send Upon Fail                      (OOS code)
 9. OOS Code[0 - ff]                    (ff)

>

Please select item <1 to 9>
F - Forward
ESC - prev menu; ! - main menu; CTRL+X - exit                          <1 Mngr>
```

*Figure 5-18. Configuring at the Physical Level for IPmux-2L (B)/(C)*

# Chapter 6

# Diagnostics and Troubleshooting

This chapter describes how to:

- Monitor performance
- Detect errors
- Handle alarms
- Troubleshoot problems
- Perform diagnostic tests.

## 6.1 Monitoring Performance

IPmux-2L provides powerful performance monitoring tools, which consist of the following three levels:

- E1 statistics – Status of the physical E1 parameters (signal, framing, etc.)
- LAN statistics – Ethernet connection status (speed, duplex mode, bytes transmitted & received, etc.)
- Bundle connection statistics – Bundle connection status on the Ethernet/IP network level.

### Displaying E1 Statistics

E1 statistics refer to the physical status of the E1 traffic reaching IPmux-2L from the adjacent E1 device.

The E1 statistics parameters comply with the G.703, G.704, G.804, G.706, G.732, and G.823 standards.

E1 statistics are monitored and saved under consecutive intervals. Each interval is 15 minutes long. There are 96 intervals, which represent the last 24 hours. Whenever a new interval is started, the counters are reset to zero. The old interval shows the total of events that occurred during its 15-minite period. The current active interval is always marked as interval 0 (you will see that the Time Since counter is running). The previous interval is marked as 1 and so on. The E1 statistic counters cannot be reset manually.

➤ **To view the E1 statistics:**

1. From the Monitoring menu (*Figure 6-1*), select **TDM**.

   The Statistics/E1 screen appears (see *Figure 6-2*).

2. From the Statistics/E1 menu, type **F** to select the E1 link that you intend to monitor.

3. Select **Interval**, enter the number of the interval whose statistics you wish to display, and press **Enter**

```
                  RAD IPmux-2L
Monitoring

 1. TDM                                >
 2. HS                                 >
 3. Ethernet                           >
 4. Connection                         >
 5. Current Alarm                      >
 6. Event Log                          >

>

Please select item <1 to 6>

ESC - prev menu; ! - main menu; CTRL+X - exit                        <1 Mngr>
```

*Figure 6-1. Statistics Menu*

```
                  RAD IPmux-2L
Statistics/E1

                TDM Channel ID :        1

LOS:                (  0)                 DM:                   (  0)
LOF (Red):          (  0)                 ES:                   (  0)
LOMF:               (  0)                 SES:                  (  0)
RAI (Yellow):       (  0)                 UAS:                  (  0)
AIS:                (  0)                 BES:                  (  0)
FEBE:               (  0)
LCV:                (  0)

Time since          (520)                 Valid intervals       (1~96)
 1. Interval           ...             (0)

>

Please select item <1 to 1>
F - Forward
ESC - prev menu; ! - main menu; CTRL+X - exit                        <1 Mngr>
```

*Figure 6-2. E1 Statistics*

*Table 6-1. E1 Statistics*

| Alarm | Description |
|---|---|
| LOS (Red) | Number of seconds with Loss of Signal. A Loss of Signal indicates that there is either no signal arriving from the adjacent E1 device or no valid E1 voltage mask or no voltage alteration between positive and negative amplitudes.<br>For E1 links, the LOS counter will increase by one for each second during which a consecutive 255 pulses have no pulse of negative or positive polarity.<br>A LOS alarm is also indicated by the rear panel E1 LOC LED (red). The LED light goes out indicates that the E1 synchronization has been restored).<br>Recommendations:<br>Check the physical layer (connectors, cables, etc.) |
| LOF (Red) | Number of seconds with Loss of Frame. A Loss of Frame indicates a second that IPmux-2L lost E1 synch opposite its adjacent E1 device.<br>In more detail, this is a period of or 100 msec for E1, during which an OOF (Out Of Frame) error persisted and no AIS errors were detected.<br>For E1 links an OOF defect is declared when three consecutive frame alignment signals have been received with an error.<br>A LOF alarm is also indicated by the rear panel E1 LOC LED (red).<br>When the IPmux-2L enters a red alarm condition, it sends an Yf bit (yellow alarm or RAI) towards the adjacent E1 device.<br>Recommendations:<br>Check all framing related parameters for E1, and physical connections. |
| LCV | Number of seconds with Line Code Violations. A Line Code Violation indicates an error on the pulse structure, either a **Bipolar Violation (BPV)** or an **Excessive Zeros (EXZ) error event**.<br>BPV is the occurrence of a pulse with the same polarity as the previous pulse.<br>EXZ is the occurrence of a zero string greater than 15 for AMI.<br>For an E1 link, the LCV counter will increase by one, for each second during which a BPV or EXZ errors have occurred.<br>Complies with ITU-TI.431, 0.161, G775 and G.821 standards.<br>Recommendations:<br>Check physical link for bad/loose connection, impedance matching (balanced or unbalanced) and noisy environment. |
| RAI (Red) | Number of seconds with Remote Alarm Indicators. A Remote Alarm Indicator is sent by a device when it enters RED state (loses sync).<br>**RAI Alarm** indicates that the adjacent E1 device had lost E1 synch and hence sent an RAI towards the IPmux-2L, which entered a Yellow alarm mode (similarly, IPmux-2L sends RAI towards adjacent E1 when IPmux-2L enters LOF state (Red alarm).<br>In both E1 links the RAI counter increases by one for each second during which an RAI pattern is received from the far end framer.<br>The RAI alarm is indicated by the rare panel REM LED (red).<br>Recommendations:<br>Check reason for E1 device to be in LOF (out of synch state) by checking physical link integrity at the Tx direction of the IPmux-2L towards E1 device and framing related parameters. |

| Alarm | Description |
|---|---|
| AIS | Number of seconds with Alarm Indication Signals. An Alarm Indication Signal implies an upstream failure of the adjacent E device. AIS will be sent to the opposite direction of which the Yellow alarm is sent.<br>For E1 links, the AIS counter will increase by one for each second during which a string of 512 bits contains fewer than three zero (0) bits.<br>The AIS condition is indicated by the rear panel E1 LOS LED (red).<br>Recommendations:<br>Check why the E1 device is sending AIS (all ones) stream towards IPmux-2L, for example, Red alarm on a different interface of E1 device (upstream). |
| FEBE | Number of seconds with Far End Block Errors. The FEBE is sent to transmitting device notifying that a flawed block has been detected at the receiving device. Exists only for E1 CRC-4 modes.<br>The FEBE counter will increase by one for each second during which the FEBE indication is received.<br>Recommendation:<br>Check physical link integrity. |
| BES | Bursty Errored Seconds (also known as Errored seconds type B) are seconds during which fewer than 319 and more than one CRC errors occurred with neither AIS nor SEF (Severely Errored Frames) detected. The BES counter will increase by one for each second containing the condition described above. The CRC is calculated for the previous frame in order to prevent processing delay.<br>Complies with AT&T TR-62411 and TR-54016 standards. Not applicable if the line type is set to Unframed. Available only at E1-CRC4 modes (performance monitoring functionality).<br>Recommendations:<br>Check physical link integrity, G.704 frame format integrity and Sync. (The CRC bits are included in TS0 for E1 multiframe links). |
| DM | A Degraded Minute is calculated by collecting all the available seconds, subtracting any SES and sorting the result in 60-second groups.<br>The DM counter will increase by one for each 60-second group in which the cumulative errors during the 60-second interval exceed 1E-6.<br>Available in E1-CRC4 modes only, (performance monitoring functionality).<br>Recommendations:<br>See BES recommendations. |
| ES | An Errored Second is a second containing one or more of the following:<br>• CRC error<br>• SEF (OOF)<br>• If SES is active ES runs for 10 seconds and then stops.<br>Recommendations:<br>Check physical link integrity. Follow the recommendation concerning LOF, BEF and AIS. |
| SES | A Severely Errored Second is a second containing one of the following:<br>• 320 or more CRC errors events<br>• One or more OOF defect<br>• The SES counter will be cleared after reaching 10 and an UAS will then be activated.<br>Recommendations:<br>Check physical link integrity. See also ES alarm recommendation. |

| Alarm | Description |
|---|---|
| UAS | Unavailable Second parameter refers to the number of seconds during which the interface is unavailable. The UAS counter will start increasing after 10 consecutive SES occurrences and will be deactivated as a result of 10 consecutive seconds without SES. After SES clearance the UAS counter will then diminish 10 seconds from the overall count.<br>Recommendations:<br>See above recommendations. |
| LOMF | Number of seconds of Loss of Multi Frame. A Loss of Multi Frame indicates a second with no sync on the multi frame mode, i.e., the receiving device is unable to detect the four ABCD bits pattern on. The LOMF alarm is also indicated by the front panel ALM LED (red). TS16 MSB in frame 0 for two consecutive multiframes. Available only for E1 multiframe mode (CAS).<br>Recommendations:<br>Check physical link integrity, signaling method (CAS enable only), and framing-related parameters. |

## Displaying High-Speed Data Port Status

You can display status of the high-speed data port.

➤ **To view the port status:**

- From the Monitoring menu, select **HS**.

  The HS status screen appears (see *Figure 6-3*), displaying the actual control state.

```
                    RAD IPmux-2L
HS


         RTS/Control State.................(OFF)


>

ESC - prev menu; ! - main menu; CTRL+X - exit                          <1 Mngr>
```

*Figure 6-3. HS status*

## Displaying LAN Status and Statistics

You can display status and statistic data for the network and user Ethernet ports.

➤ **To view the port status:**

1. From the Monitoring menu, select **Ethernet**.

   The Ethernet menu appears (see *Figure 6-4*).

2. Select **Status**.

   The Ethernet status screen appears (see *Figure 6-5*).

```
                  RAD IPmux-2L
Ethernet

 1. Status                              >
 2. Port Statistics                     >

>

Please select item <1 to 2>

ESC - prev menu; ! - main menu; CTRL+X - exit                          <1 Mngr>
```

*Figure 6-4. Ethernet menu*

```
                  RAD IPmux-2L
Status

               Port                     (Eth1/User Port)

  Port Role                             (User Port)
  Administrative Status                 (Enable)
  Operational Status                    (Up)
  Auto Negotiation                      (Enable)
  Speed and Duplex                      (100M full duplex)

>

F - Forward
ESC - prev menu; ! - main menu; CTRL+X - exit                          <1 Mngr>
```

*Figure 6-5. Ethernet status*

➤ To view the Ethernet statistics:

1. From the Monitoring menu, select **Ethernet** and then **Port Statistics**.

   The Port Statistics screen appears (see *Figure 6-6*).

2. From the Port Statistics screen, type **F** to toggle between network and user interfaces. *Table 6-2* describes the LAN statistics data.

3. Type **C** to reset the counters.

```
                RAD IPmux-2L
Port Statistics

              Port                    (Eth1/User Port)

Counter                               ---RX---                    ---TX---
Total Correct Frames                  0                             0
Total Correct Octets                  0                             0
FCS Errors                            0                             0
Jabber Errors                         0                             --
Fragments Errors                      0                             --
Undersized Frames                     0                             --
Oversized Frames                      0                             --
Collisions                            --                            0

Unicast Frames                        0                             0
Multicast Frames                      0                             0
Broadcast Frames                      0                             0
>

F - Forward; C-Clear
ESC - prev menu; ! - main menu; CTRL+X - exit                       <1 Mngr>
```

*Figure 6-6. Ethernet Statistics*

*Table 6-2. LAN Statistics Parameters*

| Parameter | Description |
|---|---|
| Frames Received | |
| Total Correct Frames | The total number of correct frames received. When a valid connection is established the number should increase steadily. |
| Total Correct Octets | The total number of octets (bytes) received. When a valid connection is established the number should increase steadily. |
| FCS Errors | The amount of frames with invalid CRCs. |
| Jabber | The number of frames that are too long and have an invalid CRC.<br>A jabber is transmission by a data station beyond the time interval allowed by the protocol, usually affecting the rest of the network. In an Ethernet network, devices compete for use of the line, attempting to send a signal and then retrying in the event that someone else tried at the same time. A jabber can look like a device that is always sending, effectively bringing the network to a halt.<br>Recommendations<br>Check network interface card or any other transmitting devices and external electrical interference. |
| Fragments Errors | The number of frames that are shorter than 64 bytes and have an invalid CRC. |
| Oversize Frames | Number of frames exceeding the maximum allowed frame size2048 octets, but are otherwise valid Ethernet frames (good CRC). |
| Undersized Frames | Number of frames received that were less than 64 octets long, but are otherwise valid Ethernet frames (good CRC). |

| Parameter | Description |
|---|---|
| Unicast Frames | Number of correct unicast frames received. |
| Multicast Frames | Number of correct multicast frames received. |
| Broadcast Frames | Number of correct broadcast frames received. |
| **Frames Transmitted** | |
| Total Correct Frames | The number of frames successfully transmitted. When a valid connection is established the number should increase steadily. |
| Total Correct Octets | The number of octets successfully transmitted. When a valid connection is established the number should increase steadily. |
| FCS Errors | The amount of frames with invalid CRCs. |
| Collisions | The number of successfully transmitted frames which transmission is inhibited by a collision event. A collision occurs in half-duplex connection when two devices try to transmit at the same time. This counter tracks the number of times frames have collided. This event exists only in Half Duplex mode, which is not recommended in an IPmux-2L application.<br>Recommendations:<br>Many collisions indicate that the traffic is too heavy for a half-duplex media. Set to a Full-Duplex environment if possible. |
| Unicast Frames | Number of unicast frames successfully transmitted. |
| Multicast Frames | Number of multicast frames successfully transmitted. |
| Broadcast Frames | Number of broadcast frames successfully transmitted. |

## Displaying Bundle Connection Statistics

For IPmux-2L, the connection screen provides information about the integrity of the TDMoIP connection, including the status of the jitter buffer. (Each bundle has its own independent jitter buffer).

➤ **To display the bundle connection statistics information:**

1. From the Monitoring menu, select **Connection**.

   The Connection Statistics screen is displayed (see *Figure 6-7*).

2. Select **Bundle ID**, enter the number of the bundle whose statistics you wish to display, and press **Enter.**
3. Select **Interval**, enter the number of the interval whose statistics you wish to display, and press **Enter.**

```
                  RAD IPmux-2L
Statistics/Connection

   Bundle/OAM Status (Connected/Synchronized)

 Sequence errors:                     ...(0)
 Jitter buffer underflows:            ...(5)
 Jitter buffer overflows:             ...(1)
 Max Jitter buffer deviation [msec]:  ...(5)
 Min Jitter buffer level [msec]:      ...(0)
 Max Jitter buffer level [msec]:      ...(10)
 Total rx frames:                     ...(1155685)
 Total tx frames:                     ...(1170122)
 Time since  (  7)     Valid intervals  (1~96)
 1. Bundle ID[1-64]                     (1)
 2. Interval[0-96]                      (0)

>

Please select item <1 to 2>
F - Forward
ESC - prev menu; ! - main menu; CTRL+X - exit; C-Clear                <1 Mngr>
```

*Figure 6-7. Connection Statistics Screen*

*Table 6-3. Bundle Connection Statistics Parameters*

| Parameter | Description |
|---|---|
| Sequence Errors | The number of seconds with sequence errors since the last clear.<br>Each packet transmitted by IPmux-2L holds a sequence number. The receiving IPmux-2L checks these numbers at the receive mechanism and expects to see that each new incoming packet is "in sequence" relative to the previous one (i.e., packet no. 5 is received after no. 4). When, for some reason, this is not the case (i.e., next packet is not in sequence relative to the previous one), this means that there had been a problem with packet flow integrity (and hence data/voice integrity). IPmux-2L will indicate this by increasing the "Sequence Errors" counter by one.<br>There may be two reasons for a Sequence Error notification:<br>Packet or packets are lost somewhere along the network.<br>Re-ordering of packets by network.<br>Packet re-ordering may occur due to queuing mechanisms, re-routing by the network, or when the router updates very large routing tables.<br>Recommendations:<br>• Make sure IPmux-2L traffic has sufficient bandwidth.<br>• Make sure Ethernet connection is functioning properly (see *Displaying LAN Status and Statistics* above.)<br>• Make sure Ethernet/IP network provides priority (Quality Of Service) to the IPmux-2L traffic. Priority may be achieved by three means: VLAN tagging, IP TOS marking or by using the constant 2142 decimal value at the "UDP destination Port" field of each TDMoIP packet.<br>• Verify that the IP network devices (switches/routers/modems/etc.) are capable of handling the IPmux-2L PPS rate (Packets Per Second).<br>• Make sure the network devices do not drop/lose/ignore packets.<br>***Note**: IPmux-2L may support a "reordering mechanism", which can sort packets back to their original order in some situations.* |

| Parameter | Description |
|---|---|
| Jitter Buffer Underflows | The number of seconds with jitter buffer underflows since the last clear.<br>IPmux-2L is equipped with a "Packet Delay Variation Tolerance" buffer, also called a "jitter buffer", responsible for compensating for IP networks delay variation (IP jitter). The jitter buffer is configured in milliseconds units and exists for each bundle independently.<br>Explanation:<br>Packets leave the transmitting IPmux-2L at a constant rate, but the problem is that they are reaching the opposite IPmux-2L at a rate which is NOT constant, due to network delay variation (caused by congestion, re-routing, queuing mechanisms, wireless media, half-duplex media, etc.). The TDM devices at both ends require a constant flow of data, so they can't tolerate delay variation. Therefore the jitter buffer is required in order to provide the TDM equipment with a synchronous and constant flow.<br>This is done as follows:<br>• Upon startup, the jitter buffer stores packets up to its middle point (the number of packets correlates to the buffer's configured depth in milliseconds). Only after that point it starts outputting the E1 flow towards its adjacent TDM device. The stored packets assure that the TDM device will be fed with data even if packets are delayed by the IP network. Obviously, if packets are delayed too long, then the buffer is gradually emptied out until it is underflowed. This situation is called buffer starvation. Each underflow event increases the jitter buffer underflow counter by one and indicates a problem in the end-to-end voice/data integrity.<br>The second functionality of the jitter buffer is that in adaptive mode the jitter buffer is also a part of a mechanism being used to reconstruct the clock of the far end TDM side.<br>An underflow situation can be a cause of:<br>• Buffer starvation: Packets delay variation causes the buffer to empty out gradually until it is underflowed.<br>• Continuous Sequence Errors. The sequence error means a halt in the valid stream of packet arrival into the jitter buffer.<br>• Packets are being stopped/lost/dropped.<br>• Too small jitter buffer configuration that can't compensate for the network delay variation.<br>• When all system elements are not locked on the same master clock, it will lead to a situation in which data is clocked out of the jitter buffer at a rate different from the one it is clocked into. This will gradually result in either an overflow or underflow event, depending on which rate is higher. The event will repeat itself periodically as long as the system clock is not locked.<br>• When an overflow (see below) situation occurs, IPmux-2L instantly flushes the jitter buffer, causing a forced underflow. So when you need to calculate the real underflow events and not the self-initiated ones, subtract the number of overflows from the total number of underflows counted by the device.<br>Recommendations:<br>• Try increasing the jitter buffer size.<br>• Check reasons for sequence errors or lost/dropped packets (if present), system clocking configuration, Ethernet environment (full duplex) and connection, packets drop/loss/ignore by routers/switches or non-uniform packets output by routers/switches due to queuing mechanisms.<br>• Make sure the same amount of TS for bundle is configured on each side of the IPmux-2L application, and that the "TDM bytes in frame" parameter is identical in both IPmux-2L units.<br>Make sure Ethernet/IP network provides priority (Quality Of Service) to the IPmux-2L traffic. Priority may be achieved by three means: VLAN tagging, IP TOS marking or by using the constant 2142 decimal value at each IPmux-2L "UDP destination Port" field. |

| Parameter | Description |
|---|---|
| Jitter Buffer Overflows | The number of seconds with at least one jitter buffer overflow event since the last clear.<br>Explanation:<br>In steady state, the jitter buffer is filled up to its middle point, which means it has the space to hold an additional similar quantity of packets. Overflow is opposite phenomenon of the Underflow, i.e., when a big burst of packets reaches the IPmux-2L (a burst with more packets than the Jitter Buffer can store), the buffer will be filled up to its top. In this case, an unknown number of excessive packets are dropped and hence IPmux-2L initiates a forced underflow by flushing (emptying) the buffer in order to start fresh from the beginning. An overflow situation always results in an immediate Underflow, forced by the IPmux-2L. After the buffer is flushed, the process of filling up the buffer is started again, as explained above ("Underflow" section).<br>An overflow situation can be a cause of:<br>• A big burst of packets, filling up the buffer completely. The burst itself can often be a cause of some element along the IP network queuing the packets and then transmitting them all at once.<br>• Too small jitter buffer configuration.<br>• When system isn't locked on the same clock, it will lead to a situation in which data is clocked out of the jitter buffer at a rate different from the one it is clocked into. This will gradually result in either an overflow or underflow event, depending on which rate is higher. The event will repeat itself periodically as long as the system clock is not locked.<br>Recommendations:<br>Check network devices and try increasing jitter buffer configuration.<br>Check system's clocking configuration<br>Make sure the same amount of TS for bundle is configured on each side of the IPmux-2L application, and that the "TDM bytes in frame" parameter is identical in both IPmux-2L units |
| Max Jitter Buffer Deviation | The maximum jitter buffer deviation (msec) in the interval (900 sec). This is the maximum jitter level IPmux-2L had to compensate for in the selected interval. |
| Time Since (sec) | The time elapsed, in seconds, since the beginning of the selected interval. |

## 6.2 Detecting Errors

### Power-Up Self-Test

IPmux-2L performs hardware self-test upon turn-on. The self-test sequence checks the critical circuit functions of IPmux-2L (framer and bridge). The self-test results are displayed via the Diagnostics menu.

➤ **To display the self-test results:**

1. From the Main menu, select **Diagnostics**.

2. The Diagnostics menu appears (see *Figure 6-8*). From the Diagnostics menu, select **Self Test Results**.

   The Self Test Results screen appears (see *Figure 6-9*).

```
                  RAD IPmux-2L
Diagnostics

 1. Loopback E1                          >
 2. Loopback HS                          >
 3. BERT E1                              >
 4. VCT Ethernet                         >
 5. Selftest Results                     >

>

Please select item <1 to 5>

ESC - prev menu; ! - main menu; CTRL+X - exit                        <1 Mngr>
```

*Figure 6-8. Diagnostics Menu*

```
                  RAD IPmux-2L
Selftest result

        RJ021  selftest ..............  (Passed)
        SWITCH selftest ..............  (Passed)
        FRAMER selftest ..............  (Passed)

>

ESC - prev menu; ! - main menu; CTRL+X - exit                        <1 Mngr>
```

*Figure 6-9. Self Test Results Screen*

## Using Front Panel LEDs

LED indicators on the front panel IPmux-2L indicate the operating status of the module. The LED indicators are described in *Chapter 3* of this manual.

## Working with the System Log

IPmux-2L maintains a System Log file, which can hold up to 2048 events including history alarms. All events are time-stamped.

### Displaying System Log

➤ **To access the event log:**

1. From the Main menu, select Monitoring, then select Event Log.

   The Event Log menu is displayed (see *Figure 6-10*).

2. From the Event Log menu, select **Show Log**.

   The Read Log File screen appears (see *Figure 6-11*).

3. In the Show Log screen, use the < Up Arrow > and <Down Arrow > key combinations to scroll the alarm list up and down.

```
                  RAD IPmux-2L
Event Log

 1. Show Log                              >
 2. Clear Log

>

Please select item <1 to 2>

ESC - prev menu; ! - main menu; CTRL+X - exit                          <1 Mngr>
```

*Figure 6-10. System Log Menu*

```
                  RAD IPmux-2L
Show log

  Index  Log entry
^ 11    2008-01-04 14:34:58 Bundle JBC overrun threshold exceeded ON BNDL 2
| 12    2008-01-04 14:03:55 Bundle JBC underrun threshold exceeded ON BNDL 1
  13    2008-01-04 14:02:16 Bundle JBC underrun threshold exceeded OFF BNDL 1
  14    2008-01-04 14:01:42 Bundle JBC underrun threshold exceeded ON BNDL 1
  15    2008-01-04 14:00:26 "SU" login via TERMINAL
  16    2008-01-04 14:00:04 Bundle Local Fail ON BNDL 2
  17    2008-01-04 14:00:04 Bundle Local Fail ON BNDL 1
  18    2008-01-04 14:00:03 LINK DOWN ON Eth3
| 19    2008-01-04 14:00:03 LINK DOWN ON Eth2
v 20    2008-01-04 14:00:03 LINK DOWN ON Eth1

 1. Jump to log[1-26]:

>

Please select item <1 to 1>

ESC - prev menu; ! - main menu; CTRL+X - exit; ? - help                <1 Mngr>
```

*Figure 6-11. Read Log File*

*Table 6-4* presents the event types that appear in the System log alphabetically, as well as the actions required to correct the event (alarm) indication for IPmux-2L.

To correct the reported problem, perform corrective actions in the given order until the problem is corrected. If the problem cannot be fixed by carrying out the listed actions, IPmux-2L must be checked by the authorized technical support personnel.

*Table 6-4. IPmux-2L Event List*

| Event | Description | Corrective Action |
|---|---|---|
| "xxx" login failure via TERMINAL | Invalid user name or password was entered, when attempting to access IPmux-2L via local terminal | None |
| "xxx" login failure via TELNET | Invalid user name or password was entered, when attempting to access IPmux-2L via Telnet | None |
| "xxx" login via TERMINAL | User "xxx" successfully access IPmux-2L via local terminal | None |
| "xxx" login via TELNET | User "xxx" successfully access IPmux-2L via Telnet | None |
| Cold reboot. | IPmux-2L has been powered up | None |
| Date/Time error(need to be calibrated) | Device Date/Time loss | Reset the Date/Time |
| IP CHANGED FROM xxx.xxx.xxx.xxx TO xxx.xxx.xxx.xxx | IP address is changed | Check the IP setting |
| IPMASK CHANGED FROM xxx.xxx.xxx.xxx TO xxx.xxx.xxx.xxx | IP mask is changed | Check the IP setting |
| Warm reboot | IPmux-2L has been powered up | None |

### Clearing Events

➤ To clear the event log:

1. From the Event Log menu, select Clear Log.

   IPmux-2L displays the following message:
   **Log data will be cleared. Continue (Y/N)?**

2. Type **Y** to confirm the log file clearing.

## Handling Alarms

Internally, the IPmux-2L stores alarms in an alarm buffer. This alarm buffer can store up to 100 alarm messages.

The current alarms can be read on-line by the network administrator using the network management station, a Telnet host, or a supervision terminal. The network administrator can then use the various diagnostic tests to determine the causes of the alarm messages and to return the system to normal operation.

➤ To display the current alarms:

- From the Current Alarm menu (Monitoring › Current Alarm), select System Alarm or Port Alarm.

  The System or Port Alarm screen is displayed.
  The screen shows the alarms stored in the buffer (up to 100), listing for each alarm its index and the alarm message.

```
                    RAD IPmux-2L
System Alarm

  Index  Alarm entry
  1      CLOCK WAS CHANGED TO FALLBACK


>

ESC - prev menu; ! - main menu; CTRL+X - exit                    <1 Mngr>
```

*Figure 6-12. System Alarm Screen*

➤ To mask alarms:

1. From the Configuration › Management menu, select **Alarm Trap Mask**.

   The Alarm Trap Mask menu appears (see *Figure 6-13*).

2. From the Alarm Traps Mask menu, select **Alarm ID** to choose alarm that you intend to mask:

   - LOS
   - LOF
   - AIS
   - RDI
   - FEBE
   - BundleConnectivity

```
                    RAD IPmux-2L
Management

 1. Device Info                        >
 2. Management Access                  >
 3. Authentication/Community           >
 4. Manager List                       >
 5. Alarm Trap Mask                    ()

>

Please select item <1 to 5>

ESC - prev menu; ! - main menu; CTRL+X - exit                    <1 Mngr>
```

*Figure 6-13. Alarm Trap Mask Menu*

*Table 6-6* presents the alarm messages displayed on the IPmux-2L control terminal in alphabetical order, and lists the actions required to correct the alarm condition.

*Table 6-5. IPmux-2L Alarm Messages*

| Terminal Message | Alarm Number | Description | Corrective Actions | Severity | Type |
|---|---|---|---|---|---|
| AIS SYNC LOSS | 24 | Local loss of frame synchronization alarm on the specified link, caused by AIS condition | Problem at the equipment connected to the remote end of the link | MAJOR | ON/OFF |
| AIS OCCURED | 23 | AIS is being detected on the link | Problem at the equipment connected to the remote end of the link | MAJOR | ON/OFF |
| BPV ERROR | 30 | Bipolar violations in the in the E1 link receive signal. Updated once per second | Have the corresponding link checked. Perform the power-up self-test and replace the IPmux-2L if a failure is detected | MINOR | ON |
| CLOCK WAS CHANGED TO FALLBACK | 02 | IPmux-2L switched to the fallback clock source, because the master clock source failed | Check the master clock source. A clock source is replaced as a result of failure under the following conditions:<br>1. E1 - fails during local loss of frame synchronization on the main link<br>2. HS - fails when the data channel equipment is disconnected or inoperative (DTR line not asserted) | MINOR | ON |
| CLOCK WAS CHANGED TO INTERNAL | 03 | IPmux-2L switched to the internal clock source, because both the master and the fallback clock sources failed | 1. Check the two clock sources.<br>2. Perform the power-up self-test and replace the IPmux-2L if a failure is detected | MINOR | ON |
| CLOCK WAS CHANGED TO MASTER | 04 | The IPmux-2L switched back to the clock source selected as the master source | Normal state - no action required | MINOR | ON |
| CRC-4 ERROR | 32 | CRC-4 errors detected in the E1 link receive signal. Updated once per second. | 1. Have the link checked.<br>2. Perform the power-up self-test and replace the IPmux-2L if a failure is detected | MINOR | ON |
| CRC MF ALARM | 34 | Local loss of synchronization to the CRC-4 multiframe on the E1 link (only on E1 port operating with CRC-4 enabled) | 1. Check cable connections to the port connector.<br>2. Check line and/or other communication equipment | MINOR | ON |

| Terminal Message | Alarm Number | Description | Corrective Actions | Severity | Type |
|---|---|---|---|---|---|
| | | | providing the link to the remote unit.<br>3. Replace the IPmux-2L unit. | | |
| ETH LINK DOWN | 11 | Ethernet link down. | Have the link checked. | MAJOR | ON/OFF |
| EXCESSIVE BPV | 22 | The rate of bipolar violations in the main or sublink receive signal exceeds 1 × 10-6 during a measurement interval of 1000 seconds | 1. Problem in the network facilities used by the corresponding link.<br>2. Turn the IPmux-2L off for a few minutes, and then turn it back on and read the alarm messages generated during the power-up self-test. Rplace the IPmux-2L if a failure is detected | MAJOR | ON/OFF |
| EXCESSIVE ERR RATIO | 31 | The bit error rate of the link receive signal exceeds 1 × 10-3 | 1. Problem in the network facilities used by the corresponding link.<br>2. Turn the IPmux-2L off for a few minutes, and then turn it back on and read the alarm messages generated during the power-up self-test. Replace the IPmux-2L if a failure is detected | MAJOR | ON/OFF |
| FEBE ERROR | 37 | FEBE error detected in the E1 link receive signal. | 1. Have the link checked.<br>2. Perform the power-up self-test and replace the IPmux-2L if a failure is detected | MINOR | ON/OFF |
| FRAME SLIP | 29 | E1 frame slips are detected (not displayed during local loss of frame synchronization). Updated once per second | 1. Incorrect selection of master clock source<br>2. Problem at far end (unstable clock source)<br>3. Replace the IPmux-2L only if steps 1 and 2 do not correct the problem. | MAJOR | ON |
| LOCAL MF ALARM | 26 | Local loss of multiframe synchronization alarm on the specified link | 1. Check that the correct framing mode is used at the local and remote ends.<br>2. Perform the corrective actions listed for LOCAL SYNC LOSS. | MAJOR | ON/OFF |

| Terminal Message | Alarm Number | Description | Corrective Actions | Severity | Type |
|---|---|---|---|---|---|
| LOCAL SYNC LOSS | 25 | Local loss of frame synchronization alarm on the specified link | 1. Check cable connections to the link connector.<br>2. Check line and/or other communication equipment providing the link to the remote IPmux-2L<br>3. Replace the IPmux-2L | MAJOR | ON/OFF |
| REMOTE MF ALARM | 27 | Remote loss of multiframe synchronization alarm on the specified link | Problem at the remote equipment | MAJOR | ON/OFF |
| REMOTE SYNC LOSS | 28 | Remote loss of frame synchronization alarm on the specified link | Problem at the remote equipment. Perform the following checks on the remote equipment:<br>1. Check cable connections to the link connector.<br>2. Check line and/or other communication equipment providing the link to the remote equipment.<br>3. Replace the equipment | MAJOR | ON/OFF |
| SELF TEST ERROR | 08 | A problem has been detected during IPmux-2L self-test | Replace the IPmux-2L | MAJOR | ON/OFF |
| SIGNAL LOSS | 21 | Loss of main or sublink receive signal | 1. Check cable connections to the link connector.<br>2. Check line and/or other communication equipment providing the link to the remote unit.<br>3. Perform the power-up self-test and replace the IPmux-2L if a failure is detected | MAJOR | ON/OFF |

## 6.3 Troubleshooting

*Table 6-6* presents the event types as they appear on the Event Log File and lists the actions required to correct the event (alarm) indication.

*Table 6-6. Troubleshooting Chart*

| Fault | Probable Cause | Remedial Action |
|---|---|---|
| E1 equipment connected to IPmux-2L is not synchronized with IPmux-2L. | Configuration or physical layer problems | 1. Check cables and physical connectivity.<br>2. Check IPmux-2L E1 configuration and, if necessary, other IPmux-2L parameters.<br>3. Check E1 physical connection (use loopbacks). |
| Slips and errors in E1 equipment | • Ethernet port in switch and IPmux-2L are not in the same rate or duplex mode<br>• Ethernet port is set to work in half duplex mode (may cause extreme PDV because of collisions and backoffs)<br>• Timing configuration is not properly set (periodic buffer under/overflows shown on IP channel status menu)<br>• Network PDV or lost frames | 1. Check E1 physical connection (use loopbacks).<br>2. Check timing settings according to explanation in this manual.<br>3. Check switch and IPmux-2L port configuration (negotiation, rate, duplex mode).<br>4. Check PDV introduced by the network, and, if necessary, increase PDVT jitter buffer setting. |

## 6.4 Testing IPmux-2L

Diagnostic capabilities of IPmux-2L include:

- Activating loopbacks (internal and external)
- Activating BERT (internal and external)
- Activating Ethernet cable test.

# Running Diagnostic Loopbacks

## External Loopback

IPmux-2L can be set to start an external loopback to test the connection between the E1 port and the PBX. In this mode, data coming from the PBX is both looped back to the PBX and transmitted forward to the IP network (see *Figure 6-14*).

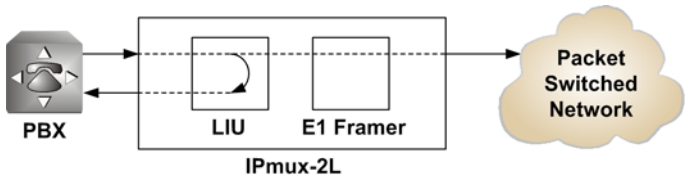


*Figure 6-14. External Loopback*

## Internal Loopback

The E1 module can be set to start an internal loopback to test the connection between the E1 port and the IP network. In this mode, data coming from the IP network is both looped back to the IP network and transmitted forward to the PBX connected to the E1 port (see *Figure 6-15*).

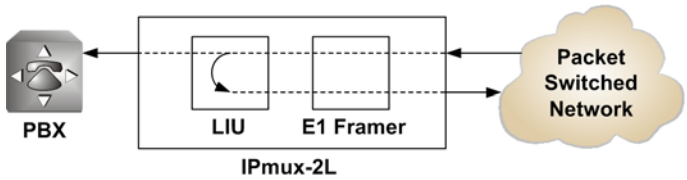


*Figure 6-15. Internal Loopback*

➤ To run a loopback:

1. From the Diagnostics menu (*Figure 6-8*), select **Loopback**.

   The Loopback menu is displayed (see *Figure 6-16*).

2. From the Loopback menu, type **F** to select the E1 link that you intend to test.
3. From the Loopback menu, select **Loopback state**, and choose loopback that you intend to run (Internal or External).

```
                    RAD IPmux-2L
Loopback E1

        TDM channel ID 1
 1. Loopback state                      (Disable)

>

Please select item <1 to 1>
F - Forward
ESC - prev menu; ! - main menu; CTRL+X - exit                          <1 Mngr>
```

*Figure 6-16. Loopback Menu*

## Running E1 BER Test

Internal or external BER test can be activated on the E1 port. During the external BER test period, the local service is disconnected and an internal pattern generator connects a digital test signal to the transmit input of the corresponding service channel (see *Figure 6-17*, *Figure 6-18*).

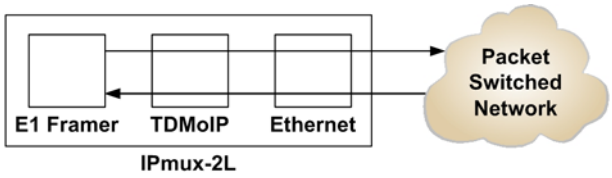


*Figure 6-17. Internal BERT*

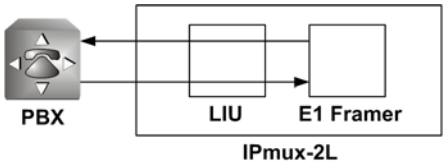


*Figure 6-18. External BERT*

➤ **To run a BER test:**

1. From the Diagnostics menu, select **BERT E1**.

   The BERT E1 menu is displayed as follow.

```
                  RAD IPmux-2L
BERT E1

         TDM Channel ID :  1
 1. BERT Pattern                        (Disable)
 2. BERT Timeslots                      (1-31)
 3. BERT Status                         (OFF)
 4. Single Error Inject                 <OFF>
 *. BERT ESs                            <0>
 *. BERT SYNC LOSs                      <0>
 *. BERT Error Bits                     <0>
 *. BERT Runtime                        <0>

Please select
F - Forward; I - Inject Single Error; C - Clear BERT Results
ESC - prev menu; ! - main menu; CTRL+X - exit; ? - help                <1 Mngr>
```

*Figure 6-19. BERT E1 Menu*

2. Type **F** to select the E1 link that you intend to test.
3. Select **BERT pattern**, and choose a pattern.
4. Select **BERT timeslots**, and choose timeslots that you intend to test.
   You can select multiple TS for BERT test. For example: 1, 3, 5–10, 20–32. Use comma to separate timeslots, hyphen to input a sequence of timeslots.
5. Select **BERT status**, and choose BERT that you intend to run (internal or external) to start BER test.

6. You can Select **Single error inject**, and press "s"
   or
   Type "i" to inject single error.

```
                 RAD IPmux-2L
BERT E1

         TDM Channel ID :  1
 1. BERT Pattern                      <2^11-1>
 2. BERT Timeslots                    <1-5,13,15>
 3. BERT Status                       (External BERT)
 4. Single Error Inject               <OFF>
 *. BERT ESs                          <2>
 *. BERT SYNC LOSs                    <0>
 *. BERT Error Bits                   <3>
 *. BERT Runtime                      <20>

>
3 error injected.
Please select item <1 to 4>
F - Forward; I - Inject Single Error; C - Clear BERT Results
ESC - prev menu; ! - main menu; CTRL+X - exit; ? - help              <1 Mngr>
```

*Figure 6-20. BER test Screen*

## Running Virtual Cable Test

IPmux-2L supports Virtual Cable Test (VCT) to diagnose the attached cable plant.

➤ To run a virtual cable test:

1. From the Diagnostics menu, select **VCT Ethernet**.

   The Virtual Cable Test screen is displayed as follow.

```
                  RAD IPmux-2L
Virtual Cable Test

                Port                    (Eth1/User Port)
RX PAIR :

TX PAIR :

>

F - Forward; S-Start
ESC - prev menu; ! - main menu; CTRL+X - exit                        <1 Mngr>
```

*Figure 6-21. Virtual Cable Test Screen*

2. Type **S** to start the virtual cable test.

   The Virtual Cable Test results are displayed as follow.

```
                  RAD IPmux-2L
Virtual Cable Test

                Port                    (Eth1/User Port)

RX PAIR :

Cable Test Passed. Cable is open.
Approximatly 3 meters from the tested port.

TX PAIR :

Cable Test Passed. Cable is open.
Approximatly 3 meters from the tested port.

>

F - Forward; S-Start
ESC - prev menu; ! - main menu; CTRL+X - exit                          <1 Mngr>
```

*Figure 6-22. Virtual Cable test results Screen*

```
                  RAD IPmux-2L
Virtual Cable Test

                Port                    (Eth1/User Port)

RX PAIR :

Cable Test Passed. No problem found.

TX PAIR :

Cable Test Passed. No problem found.

>

F - Forward; S-Start
ESC - prev menu; ! - main menu; CTRL+X - exit                          <1 Mngr>
```

*Figure 6-23. Virtual Cable Test Results Screen*

## 6.5 Frequently Asked Questions

Q: How does the IPmux-2L handle/propagate alarms on the TDM and Ethernet side?

A: The IPmux-2L handles alarms on the TDM and Ethernet side in the following manner:

TDM side alarms
Unframed mode:

- In case of LOS (Loss Of Signal) on the local IPmux-2L side, AIS will be sent towards the IP side, and will then be transferred over the E1 to the remote TDM device.
- All other alarms sent from the near-end TDM device (including information on timeslot 0), will be propagated transparently by the local IPmux-2L, to the remote end TDM device (over the IP connection).

Framed mode:

In case of LOS/LOF/AIS detected on the local IPmux-2L side, a user-configurable conditioning pattern (00 to FF) will be sent on the relevant timeslots (over the IP connection), to the far-end TDM device. A user-configurable conditioning pattern can also be applied on the ABCD bits (CAS signaling 1 to F) going towards the remote PBX.
The frame synch on the E1 level is maintained in favor of the end TDM devices.

Ethernet Side Alarms
Unframed mode:
In case of local failure on the IPmux-2L, or a situation of jitter buffer underflow/overflow, an (unframed) AIS will be sent towards the near-end TDM side

Framed mode:
In case of local failure on the IPmux-2L, or situation of jitter buffer underflow/overflow, a conditioning pattern (00 to FF) will be sent towards the near-end TDM device on the timeslots related to that specific bundle. A user-configurable conditioning pattern can also be applied on the ABCD bits (CAS signaling 1 to F), going towards the local TDM device.
In this case the synch on the E1 level is maintained in favor of the TDM end devices.

Q: How can I ensure the IPmux-2L TDMoIP traffic priority over an IP Ethernet network?

A: The IPmux-2L units offer three different methods of the TDMoIP traffic prioritization over an IP/Ethernet network:

- VLAN ID (Layer 2)
- ToS field (Layer 3)
- UDP destination port (Layer 4).

Each QoS feature is based on a different OSI level and can be used individually in order to ensure the TDMoIP traffic priority. When determining which feature to use, it is important to verify that the different elements on the network, (switches / routers / etc.), support the selected priority mechanism and are also configured to give the highest priority to the labeled IPmux-2L traffic.
Notice that the priority is given to the TDMoIP traffic by the network elements and the IPmux-2L is merely tagging the packets.

**VLAN ID**

The IPmux-2L complies with the IEEE 802.1p&Q standards. This enables the user to set both VLAN ID and VLAN Priority. It adds four bytes to the MAC layer (Layer 2) of the Ethernet frame. These bytes contain information about the VLAN ID, and the VLAN priority, which runs from 0–7. The IPmux-2L only tags the packets, while the switches are responsible for giving the priority according to the VLAN info. Verify that the IPmux-2L traffic has the highest priority in the relevant Ethernet network.

**ToS**

There are several RFCs (RFC791, RFC1349, RFC2474) that define how the IP ToS should be configured. The ToS is a byte located in the IP header (Layer 3). In general the Type of Service octet, in most cases, consists of three fields: The first field, labeled "PRECEDENCE", is intended to denote the importance or priority of the datagram.
The second field, labeled "TOS", denotes how the network should make tradeoffs between throughput, delay, reliability, and cost.
The last field, labeled "MBZ" (for "must be zero") above, is currently unused.
The IPmux-2L can configure the whole IP ToS byte, and therefore it is adaptable to each RFC in the market. The IP ToS parameter in the IPmux-2L is user-configured in terms of decimal value. However, on the frame itself it of course appears in binary format. The decimal value varies between 0 and 255 (8 bits).

A configuration example:
Setting IP precedence of 101 and IP ToS of 1000 will give us the byte 10110000, which means that the IPmux-2L IP ToS parameter should be configured to 176 decimals.

**UDP Destination Port**

The IPmux-2L uses the UDP protocol (Layer 4) in order to transfer the TDMoIP traffic.
In the UDP protocol, the Destination port field is always set to the decimal value of 2142, hence all the packets leaving the IPmux-2L are tagged accordingly. This unique value was assigned to RAD by the IANA organization for TDMoIP applications.
The network elements may be used to give priority to the TDMoIP traffic according to the UDP destination field.

**Q**: Does allocating a sufficient bandwidth ensure the proper functionality of an IPmux-2L-based application?

**A**: A sufficient bandwidth is not enough to ensure a steady environment for the IPmux-2L, since networks loaded with additional non-IPmux-2L LAN traffic (e.g. PC traffic) or incompetent Ethernet/IP network may cause several problems:

- Jitter – The IPmux-2L packets may suffer a delay variation (although all the traffic will eventually pass through due to that fact that there is sufficient bandwidth). Packets will be delayed for different periods of time due to overloaded networks, queuing mechanisms, etc. IPmux-2L can compensate for some jitter but bigger jitter causes problems.
- Misordering – Packets might be sent in different order than the order in which they were originally sent from the IPmux-2L.
- Packet Loss – Packets might be dropped/ignored by some elements in the network (routers/switches) due to insufficient processing power to handle the load, queuing mechanisms, buffer overflows, etc.

Normally these problems are solved by giving priority to the IPmux-2L traffic over all other traffic.
As can be shown, even though there is sufficient bandwidth, there might still be cases in which the traffic will be transmitted from all the sources at the same time and thus create a momentary load on the network element (router/switch), even when this load that does not exceed the available bandwidth. Since the IPmux-2L is constantly transmitting, the TDMoIP traffic will always be a part of such a load.
When no priority is given to the TDMoIP traffic, the network elements will handle the TDMoIP traffic as any other type of traffic.
All the above degrade the performance of the IPmux-2L unit, although an adequate amount of bandwidth is provided for the IPmux-2L.
Refer to FAQ 3338 to understand how to check the IPmux-2L and network performance and how to solve problems.

## 6.6 Technical Support

Technical support for this product can be obtained from the local distributor from whom it was purchased.

For further information, please contact the RAD distributor nearest you or one of RAD's offices worldwide. This information can be found at www.rad.com (offices – About RAD > Worldwide Offices; distributors – Where to Buy > End Users).

# Appendix A
# Connector Wiring

## A.1 E1 Connector

### Balanced Connector

The E1 interfaces of IPmux-2L terminate in two 8-pin RJ-45 connectors, wired in accordance with *Table A-1*.

*Table A-1. E1 Port Connector Pinout*

| Pin | Designation | Direction | Function |
|---|---|---|---|
| 1 | RD (R) | Input | Receive data (ring) |
| 2 | RD (T) | Input | Receive data (tip) |
| 3, 6 | – | – | FGND |
| 4 | TD (R) | Output | Transmit data (ring) |
| 5 | TD (T) | Output | Transmit data (tip) |
| 7, 8 | – | N/A | Not connected |

### Balanced-to-Unbalanced Adapter Cable

When IPmux-2L is ordered with unbalanced E1 interface, it is necessary to convert the RJ-45 connector to the standard pair of BNC female connectors used by unbalanced E1 interfaces. For that purpose, RAD offers a 150-mm long adapter cable, CBL-RJ45/2BNC/E1/X, wired in accordance with *Figure A-1*.

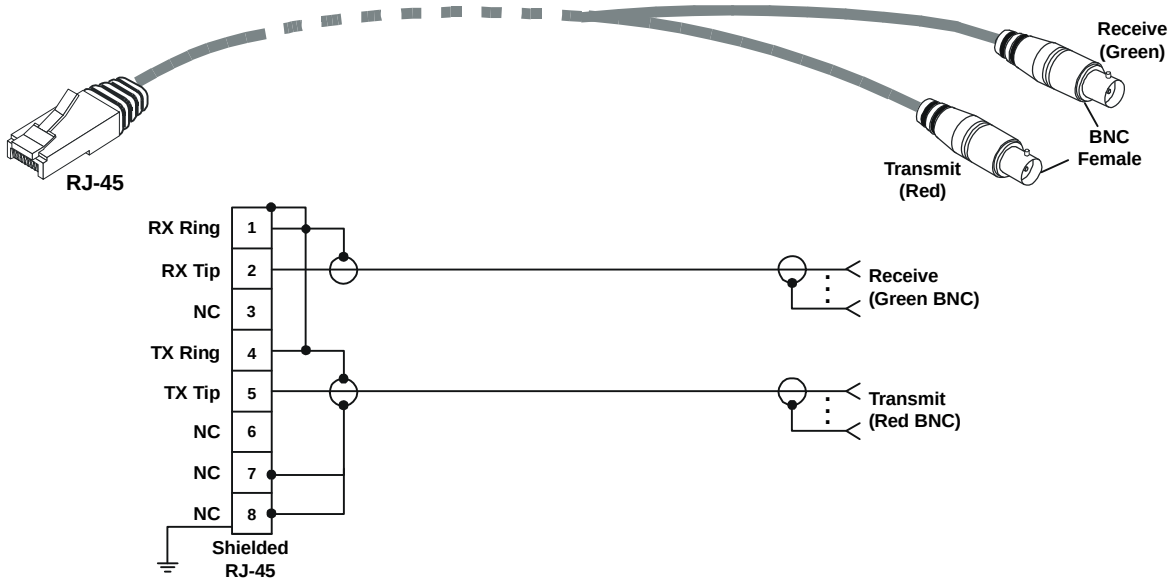


*Figure A-1. CBL-RJ45/2BNC/E1/X Cable Wiring Diagram*

## A.2 Ethernet Connectors

The network and user Ethernet electrical interfaces terminate in 8-pin RJ-45 connectors, wired in accordance with *Table A-2*.

*Table A-2. Ethernet Connector Pinout*

| Pin | Function |
|---|---|
| 1 | Tx+ |
| 2 | Tx– |
| 3 | Rx+ |
| 4 | – |
| 5 | – |
| 6 | Rx– |
| 7 | – |
| 8 | – |

## A.3 Serial Data Interface Connectors

The serial data interface of IPmux-2L is terminated in a 25-pin D-type female connector, irrespective of the channel interface type. The pin allocation in the data channel connector is given in *Table A-3*. *Figure A-2* identifies the pins of the data channel connector.

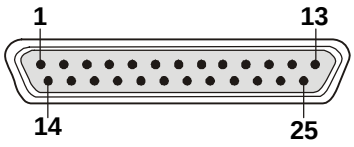


*Figure A-2. Data Channel Connector, Pin Identification*

*Table A-3. Serial Data Interface Connector, Pin Allocation*

| Pin | Direction | Designation | Function | RS-530 Circuit |
|---|---|---|---|---|
| 1 | ↔ | FG | Frame Ground | AA |
| 2 | Input | SDA | Send Data (wire A) | BA(A) |
| 3 | Output | RDA | Receive Data (wire A) | BB(A) |
| 4 | Input | RTSA | RTS (wire A) | CA(A) |
| 5 | Output | CTSA | CTS (wire A) | CB(A) |
| 6 | Output | DSRA | DSR (wire A) | CC(A) |
| 7 | ↔ | SG | Signal Ground | AB |
| 8 | Output | DCDA | DCD (wire A) | CF(A) |
| 9 | Output | RCB | Receive Clock (wire B) | DD(B) |
| 10 | Output | DCDB | DCD (wire B) | CF(B) |
| 11 | Input | SCEB | External Send Clock (wire B) | DA(B) |
| 12 | Output | SCB | Send Clock (wire B) | DB(B) |
| 13 | Output | CTSB | CTS (wire B) | CB(B) |
| 14 | Input | SDB | Send Data (wire B) | BA(B) |
| 15 | Output | SCA | Send Clock (wire A) | DB(A) |
| 16 | Output | RDB | Receive Data (wire B) | BB(B) |
| 17 | Output | RCA | Receive Clock (wire A) | DD(A) |
| 18 | Input | LLBA | Local Loopback Activation (wire A) | – |
| 19 | Input | RTSB | RTS (wire B) | CA(B) |
| 20 | Input | DTRA/RCEA | DTRA/External Receive Clock (wire A) | CD(A) |
| 21 | Input | RLBA | Remote Loopback Activation (wire A) | – |
| 22 | Output | DSRB | DSR (wire B) | CC(B) |
| 23 | Input | DTRB/RCEB | DTRB/External Receive Clock (wire B) | CD(B) |
| 24 | Input | SCEA | External Send Clock (wire A) | DA(A) |
| 25 | Output | TMA | Test Mode Indication (wire A) | – |

## V.35 Data Channel

The following sections provide information on the cable required to connect user's equipment to the V.35 interface.

## DCE Mode

This mode is used to connect to user's equipment with V.35 DTE interface. The V.35 cable coming from the user's equipment is connected to the IPmux-2L serial data interface connector through an adapter cable. The adapter cable (see *Figure A-4*) is terminated in a 25-pin male D-type connector at the IPmux-2L side, and a 34-pin female connector at the user's side. A suitable cable, designated CBL-HS2V1, is available from RAD. Cable wiring is given in *Table A-4*.

*Figure A-3. V.35 Adapter Cable for DCE Mode*

*Table A-4. Wiring of V.35 Adapter Cable for DCE Mode*

| IPmux-2L Side | Designation | Function | User's Side |
|---|---|---|---|
| 1 | FG | Frame Ground | A |
| 2 | SDA | Send Data (wire A) | P |
| 3 | RDA | Receive Data (wire A) | R |
| 4 | RTSA | RTS (wire A) | C |
| 5 | CTSA | CTS (wire A) | D |
| 6 | DSRA | DSR (wire A) | E |
| 7 | SG | Signal Ground | B |
| 8 | DCDA | DCD (wire A) | F |
| 9 | RCB | Receive Clock (wire B) | X |
| 10 | DCDB | DCD (wire B) | – |
| 11 | SCEB | External Send Clock (wire B) | W |
| 12 | SCB | Send Clock (wire B) | AA |
| 13 | CTSB | CTS (wire B) | – |
| 14 | SDB | Send Data (wire B) | S |
| 15 | SCA | Send Clock (wire A) | Y |
| 16 | RDB | Receive Data (wire B) | T |
| 17 | RCA | Receive Clock (wire A) | V |
| 18 | – | Not connected | – |
| 19 | RTSB | RTS (wire B) | – |
| 20 | RCEA | External Receive Clock (wire A) | – |
| 21 | – | Not connected | – |

| IPmux-2L Side | Designation | Function | User's Side |
|---|---|---|---|
| 22 | DSRB | DSR (wire B) | – |
| 23 | RCEB | External Receive Clock (wire B) | – |
| 24 | SCEA | External Send Clock (wire A) | U |
| 25 | – | Not connected | – |

## DTE1 Mode

This mode is used to connect to user's equipment with V.35 DCE interface that can accept, as its external clock, the receive clock signal provided by the IPmux-2L data channel.

The V.35 cable coming from the user's equipment is connected to the IPmux-2L data channel connector through an adapter cable. The adapter cable (see *Figure A-4*) is terminated in a 25-pin male D-type connector at the IPmux-2L side, and a 34-pin female connector at the user's side. A suitable cable, designated CBL-HS2V2, is available from RAD. Cable wiring is given in *Table A-5*.

*Table A-5. Wiring of V.35 Adapter Cable for DTE1 Mode*

| IPmux-2L Side | Designation | Function | User's Side |
|---|---|---|---|
| 1 | FG | Frame Ground | A |
| 2 | SDA | Send Data (wire A) | R |
| 3 | RDA | Receive Data (wire A) | P |
| 4 | RTSA | RTS (wire A) | F |
| 5 | CTSA | CTS (wire A) | – |
| 6 | DSRA | DSR (wire A) | H |
| 7 | SG | Signal Ground | B |
| 8 | DCDA | DCD (wire A) | C |
| 9 | RCB | Receive Clock (wire B) | W |
| 10 | DCDB | DCD (wire B) | – |
| 11 | SCEB | External Send Clock (wire B) | X |
| 12 | SCB | Send Clock (wire B) | – |
| 13 | CTSB | CTS (wire B) | – |
| 14 | SDB | Send Data (wire B) | T |
| 15 | SCA | Send Clock (wire A) | – |
| 16 | RDB | Receive Data (wire B) | S |
| 17 | RCA | Receive Clock (wire A) | U |
| 18 | – | Not connected | – |
| 19 | RTSB | RTS (wire B) | – |
| 20 | RCEA | External Receive Clock (wire A) | – |

| IPmux-2L Side | Designation | Function | User's Side |
|---|---|---|---|
| 21 | – | Not connected | – |
| 22 | DSRB | DSR (wire B) | – |
| 23 | RCEB | External Receive Clock (wire B) | – |
| 24 | SCEA | External Send Clock (wire A) | V |
| 25 | – | Not connected | – |

## DTE2 Mode

The DTE2 mode is used to connect to user's equipment with V.35 DCE interface that provides the transmit and receive clocks to the IPmux-2L serial data interface.

The V.35 cable coming from the user's equipment is connected to the IPmux-2L serial data interface connector through an adapter cable. The adapter cable (see *Figure A-4*) is terminated in a 25-pin male D-type connector at the IPmux-2L side, and a 34-pin female connector at the user's side. A suitable cable, designated CBL-HS2V3, is available from RAD. Cable wiring is given in *Table A-6*.

*Figure A-4. V.35 Adapter Cable Mode*

*Table A-6. Wiring of V.35 Adapter Cable for DTE2 Mode*

| IPmux-2L Side | Designation | Function | User's Side |
|---|---|---|---|
| 1 | FG | Frame Ground | A |
| 2 | SDA | Send Data (wire A) | R |
| 3 | RDA | Receive Data (wire A) | P |
| 4 | RTSA | RTS (wire A) | F |
| 5 | CTSA | CTS (wire A) | – |
| 6 | DSRA | DSR (wire A) | H |
| 7 | SG | Signal Ground | B |
| 8 | DCDA | DCD (wire A) | C |
| 9 | RCB | Receive Clock (wire B) | – |
| 10 | DCDB | DCD (wire B) | – |
| 11 | SCEB | External Send Clock (wire B) | X |
| 12 | SCB | Send Clock (wire B) | – |

| IPmux-2L Side | Designation | Function | User's Side |
|---|---|---|---|
| 13 | CTSB | CTS (wire B) | – |
| 14 | SDB | Send Data (wire B) | T |
| 15 | SCA | Send Clock (wire A) | – |
| 16 | RDB | Receive Data (wire B) | S |
| 17 | RCA | Receive Clock (wire A) | – |
| 18 | – | Not connected | – |
| 19 | RTSB | RTS (wire B) | – |
| 20 | RCEA | External Receive Clock (wire A) | Y |
| 21 | – | Not connected | – |
| 22 | DSRB | DSR (wire B) | – |
| 23 | RCEB | External Receive Clock (wire B) | AA |
| 24 | SCEA | External Send Clock (wire A) | V |
| 25 | – | Not connected | – |

## RS-530 Data Channel

The functions of the pins in the RS-530 data channel interface connector are listed in *Table A-3*.

### DCE Mode

This mode is used to connect to user's equipment with DTE interface. The user's equipment can be directly connected to the IPmux-2L serial data interface channel connector using a standard straight RS-530 cable (i.e., a cable wired point-to-point). The straight cable is terminated in a 25-pin male D-type connector at the IPmux-2L side.

### DTE1 Mode

This mode is used to connect to user's equipment with DCE interface that can accept, as its external clock, the receive clock signal provided by the IPmux-2L data channel.

In this case, it is necessary to connect a 25-pin male/25-pin male cross-cable wired in accordance with *Table A-7*, between the IPmux-2L data channel connector and the user's equipment RS-530 connector.

*Figure A-5. RS-530 Adapter Cable for DTE1 Mode*

*Table A-7. Wiring of RS-530 Adapter Cable for DTE1 Mode*

| IPmux-2L Side | Designation | Function | User's Side |
|---|---|---|---|
| 1 | FG | Frame Ground | 1 |
| 2 | SDA | Send Data (wire A) | 3 |
| 3 | RDA | Receive Data (wire A) | 2 |
| 4 | RTSA | RTS (wire A) | 8 |
| 5 | CTSA | CTS (wire A) | – |
| 6 | DSRA | DSR (wire A) | 20 |
| 7 | SG | Signal Ground | 7 |
| 8 | DCDA | DCD (wire A) | 4 |
| 9 | RCB | Receive Clock (wire B) | 11 |
| 10 | DCDB | DCD (wire B) | 19 |
| 11 | SCEB | External Send Clock (wire B) | 9 |
| 12 | SCB | Send Clock (wire B) | – |
| 13 | CTSB | CTS (wire B) | – |
| 14 | SDB | Send Data (wire B) | 16 |
| 15 | SCA | Send Clock (wire A) | – |
| 16 | RDB | Receive Data (wire B) | 14 |
| 17 | RCA | Receive Clock (wire A) | 24 |
| 18 | – | Not connected | – |
| 19 | RTSB | RTS (wire B) | 10 |
| 20 | RCEA | External Receive Clock (wire A) | – |
| 21 | – | Not connected | – |
| 22 | DSRB | DSR (wire B) | 23 |
| 23 | RCEB | External Receive Clock (wire B) | – |
| 24 | SCEA | External Send Clock (wire A) | 17 |
| 25 | – | Not connected | – |

## DTE2

The DTE2 timing mode is used to connect to user's equipment with DCE interface that provides the transmit and receive clocks to the IPmux-2L serial data interface. In this case, it is necessary to connect a 25-pin male/25-pin male cross-cable wired in accordance with *Table A-8*, between the IPmux-2L serial data interface connector and the user's equipment RS-530 connector.

*Table A-8. Wiring of RS-530 Adapter Cable for DTE2 Mode*

| IPmux-2L Side | Designation | Function | User's Side |
|---|---|---|---|
| 1 | FG | Frame Ground | 1 |
| 2 | SDA | Send Data (wire A) | 3 |
| 3 | RDA | Receive Data (wire A) | 2 |
| 4 | RTSA | RTS (wire A) | 8 |
| 5 | CTSA | CTS (wire A) | – |
| 6 | DSRA | DSR (wire A) | 20 |
| 7 | SG | Signal Ground | 7 |
| 8 | DCDA | DCD (wire A) | 4 |
| 9 | RCB | Receive Clock (wire B) | – |
| 10 | DCDB | DCD (wire B) | 19 |
| 11 | SCEB | External Send Clock (wire B) | 9 |
| 12 | SCB | Send Clock (wire B) | – |
| 13 | CTSB | CTS (wire B) | – |
| 14 | SDB | Send Data (wire B) | 16 |
| 15 | SCA | Send Clock (wire A) | – |
| 16 | RDB | Receive Data (wire B) | 14 |
| 17 | RCA | Receive Clock (wire A) | – |
| 18 | – | Not connected | – |
| 19 | RTSB | RTS (wire B) | 10 |
| 20 | RCEA | External Receive Clock (wire A) | 15 |
| 21 | – | Not connected | – |
| 22 | DSRB | DSR (wire B) | 23 |
| 23 | RCEB | External Receive Clock (wire B) | 12 |
| 24 | SCEA | External Send Clock (wire A) | 17 |
| 25 | – | Not connected | – |

# X.21 Data Channel

The following sections provide information on the cables required to connect user's equipment to the X.21 channel in the various timing modes.

## DCE Mode

This mode is used to connect to user's equipment with X.21 DTE interface. The X.21 cable coming from the user's equipment is connected to the IPmux-2L serial data interface connector through an adapter cable. The adapter cable (see *Figure A-6*) is terminated in a 25-pin male D-type connector at the IPmux-2L side, and a 15-pin female connector at the user's side. A suitable cable, designated CBL-HS2X1, is available from RAD. Cable wiring is given in *Table A-9*.

*Figure A-6. X.21 Adapter Cable for DCE Mode*

*Table A-9. Wiring of X.21 Adapter Cable for DCE Mode*

| IPmux-2L Side | Designation | Function | User's Side |
|---|---|---|---|
| 1 | FG | Frame Ground | 1 |
| 2 | SDA | Send Data (wire A) | 2 |
| 3 | RDA | Receive Data (wire A) | 4 |
| 4 | RTSA | RTS (wire A) | 3 |
| 5 | CTSA | CTS (wire A) | – |
| 6 | DSRA | DSR (wire A) | – |
| 7 | SG | Signal Ground | 8 |
| 8 | DCDA | DCD (wire A) | 5 |
| 9 | RCB | Receive Clock (wire B) | – |
| 10 | DCDB | DCD (wire B) | 12 |
| 11 | SCEB | External Send Clock (wire B) | – |
| 12 | SCB | Send Clock (wire B) | 13 |
| 13 | CTSB | CTS (wire B) | – |
| 14 | SDB | Send Data (wire B) | 9 |
| 15 | SCA | Send Clock (wire A) | 6 |
| 16 | RDB | Receive Data (wire B) | 11 |
| 17 | RCA | Receive Clock (wire A) | – |

| IPmux-2L Side | Designation | Function | User's Side |
|---|---|---|---|
| 18 | – | Not connected | – |
| 19 | RTSB | RTS (wire B) | 10 |
| 20 | RCEA | External Receive Clock (wire A) | – |
| 21 | – | Not connected | – |
| 22 | DSRB | DSR (wire B) | – |
| 23 | RCEB | External Receive Clock (wire B) | – |
| 24 | SCEA | External Send Clock (wire A) | – |
| 25 | – | Not connected | – |

## V.36/RS-449 Data Channel

The following sections provide information on the cables required to connect user's equipment to the V.36/RS-449 channel in the various timing modes.

### DCE Mode

This mode is used to connect to user's equipment with V.36/RS-449 DTE interface. The V.36/RS-449 cable coming from the user's equipment is connected to the IPmux-2L serial data interface connector through an adapter cable. The adapter cable (see *Figure A-7*) is terminated in a 25-pin male D-type connector at the IPmux-2L side, and a 37-pin female connector at the user's side. A suitable cable, designated CBL-HS2R1, is available from RAD. Cable wiring is given in *Table A-10*.

*Figure A-7. V.36/RS-449 Adapter Cable for DCE Mode*

*Table A-10. Wiring of V.36/RS-449 Adapter Cable for DCE Mode*

| IPmux-2L Side | Designation | Function | User's Side |
|---|---|---|---|
| 1 | FG | Frame Ground | 1 |
| 2 | SDA | Send Data (wire A) | 4 |
| 3 | RDA | Receive Data (wire A) | 6 |
| 4 | RTSA | RTS (wire A) | 7 |
| 5 | CTSA | CTS (wire A) | 9 |
| 6 | DSRA | DSR (wire A) | 11 |

| IPmux-2L Side | Designation | Function | User's Side |
|---|---|---|---|
| 7 | SG | Signal Ground | 19 |
| 8 | DCDA | DCD (wire A) | 13 |
| 9 | RCB | Receive Clock (wire B) | 26 |
| 10 | DCDB | DCD (wire B) | 31 |
| 11 | SCEB | External Send Clock (wire B) | 35 |
| 12 | SCB | Send Clock (wire B) | 23 |
| 13 | CTSB | CTS (wire B) | 27 |
| 14 | SDB | Send Data (wire B) | 22 |
| 15 | SCA | Send Clock (wire A) | 5 |
| 16 | RDB | Receive Data (wire B) | 24 |
| 17 | RCA | Receive Clock (wire A) | 8 |
| 18 | – | Not connected | – |
| 19 | RTSB | RTS (wire B) | 25 |
| 20 | RCEA | External Receive Clock (wire A) | |
| 21 | – | Not connected | – |
| 22 | DSRB | DSR (wire B) | 29 |
| 23 | RCEB | External Receive Clock (wire B) | – |
| 24 | SCEA | External Send Clock (wire A) | 17 |
| 25 | – | Not connected | – |

## DTE1 Mode

This mode is used to connect to user's equipment with V.36/RS-449 DCE interface that can accept, as its external clock, the receive clock signal provided by the
IPmux-2L data channel.

The V.36/RS-449 cable coming from the user's equipment is connected to the IPmux-2L channel connector through an adapter cable. The adapter cable (see *Figure A-7*) is terminated in a 25-pin male D-type connector at the IPmux-2L side, and a 37-pin female connector at the user's side. A suitable cable, designated CBL-HS2R2, is available from RAD. Cable wiring is given in *Table A-11*.

*Table A-11. Wiring of V.36/RS-449 Adapter Cable for DTE1 Mode*

| IPmux-2L Side | Designation | Function | User's Side |
|---|---|---|---|
| 1 | FG | Frame Ground | 1 |
| 2 | SDA | Send Data (wire A) | 6 |
| 3 | RDA | Receive Data (wire A) | 4 |
| 4 | RTSA | RTS (wire A) | 13 |
| 5 | CTSA | CTS (wire A) | – |

| IPmux-2L Side | Designation | Function | User's Side |
|---|---|---|---|
| 6 | DSRA | DSR (wire A) | 12 |
| 7 | SG | Signal Ground | 19 |
| 8 | DCDA | DCD (wire A) | 7 |
| 9 | RCB | Receive Clock (wire B) | 35 |
| 10 | DCDB | DCD (wire B) | 25 |
| 11 | SCEB | External Send Clock (wire B) | 26 |
| 12 | SCB | Send Clock (wire B) | – |
| 13 | CTSB | CTS (wire B) | – |
| 14 | SDB | Send Data (wire B) | 24 |
| 15 | SCA | Send Clock (wire A) | – |
| 16 | RDB | Receive Data (wire B) | 22 |
| 17 | RCA | Receive Clock (wire A) | 17 |
| 18 | – | Not connected | – |
| 19 | RTSB | RTS (wire B) | 31 |
| 20 | RCEA | External Receive Clock (wire A) | – |
| 21 | – | Not connected | – |
| 22 | DSRB | DSR (wire B) | 24 |
| 23 | RCEB | External Receive Clock (wire B) | – |
| 24 | SCEA | External Send Clock (wire A) | 8 |
| 25 | – | Not connected | – |

## DTE2 Mode

This mode is used to connect to user's equipment with V.36/RS-449 DCE interface that provides the transmit and receive clocks to the IPmux-2L serial data interface.

The V.36/RS-449 cable coming from the user's equipment is connected to the IPmux-2L serial data interface connector through an adapter cable. The adapter cable (see *Figure A-7*) is terminated in a 25-pin male D-type connector at the IPmux-2L side, and a 37-pin female connector at the user's side. A suitable cable, designated CBL-HS2R3, is available from RAD. Cable wiring is given in *Table A-12*.

*Table A-12. Wiring of V.36/RS-449 Adapter Cable for DTE2 Mode*

| IPmux-2L Side | Designation | Function | User's Side |
|---|---|---|---|
| 1 | FG | Frame Ground | 1 |
| 2 | SDA | Send Data (wire A) | 6 |
| 3 | RDA | Receive Data (wire A) | 4 |
| 4 | RTSA | RTS (wire A) | 13 |

| IPmux-2L Side | Designation | Function | User's Side |
|---|---|---|---|
| 5 | CTSA | CTS (wire A) | – |
| 6 | DSRA | DSR (wire A) | 12 |
| 7 | SG | Signal Ground | 19 |
| 8 | DCDA | DCD (wire A) | 7 |
| 9 | RCB | Receive Clock (wire B) | – |
| 10 | DCDB | DCD (wire B) | 25 |
| 11 | SCEB | External Send Clock (wire B) | 26 |
| 12 | SCB | Send Clock (wire B) | – |
| 13 | CTSB | CTS (wire B) | – |
| 14 | SDB | Send Data (wire B) | 24 |
| 15 | SCA | Send Clock (wire A) | – |
| 16 | RDB | Receive Data (wire B) | 22 |
| 17 | RCA | Receive Clock (wire A) | – |
| 18 | – | Not connected | – |
| 19 | RTSB | RTS (wire B) | 31 |
| 20 | RCEA | External Receive Clock (wire A) | 5 |
| 21 | – | Not connected | – |
| 22 | DSRB | DSR (wire B) | 30 |
| 23 | RCEB | External Receive Clock (wire B) | 23 |
| 24 | SCEA | External Send Clock (wire A) | 8 |
| 25 | – | Not connected | – |

## A.4 CONTROL Connector

The control terminal interface terminates in a V.24/RS-232 9-pin D-type female DCE connector. *Table A-13* lists the CONTROL connector pin assignments.

*Table A-13. CONTROL Connector Pinout*

| Pin | Function |
|---|---|
| 1 | – |
| 2 | Rx |
| 3 | Tx |
| 4 | – |
| 5 | GND |
| 6 | – |
| 7 | – |
| 8 | – |
| 9 | – |

# Appendix B

# Boot Sequence and Downloading Software

This appendix describes the IPmux-2L boot procedure via an ASCII terminal for downloading software.

The file system can hold two compressed copies of the IPmux-2L code. One copy is stored in the system zone, and the other is stored in the backup zone. The file in system zone is the default-executable IPmux-2L code. The file in backup zone is used whenever the operating file is absent or corrupted.

## B.1 Booting IPmux-2L

IPmux-2L boots up automatically. After powering up, no user intervention is required, except when the user wants to access the file system to modify or update the software or the IPmux-2L configuration.

### Accessing the Boot Manager

The Boot Manager menu is an option that allows the user to perform basic file transfer operations. These operations are all optional.

➤ **To access the Boot Manager menu:**

- Press **<Enter>** several times immediately after powering up the IPmux-2L.

  The Boot Manager menu is displayed (see *Figure B-1*).

```
=====================================================================
=              (C) RAD Data Communication                           =
=                                                                   =
=        Boot Menu         ( Version 1.02   )                      =
=                                                                   =
=     1. Boot Application from System Zone                          =
=     2. Boot from Serial Port                                      =
=     3. Restore System from Backup Zone and Run                    =
=     4. Erase Backup Zone                                          =
=     5. Erase Database                                             =
=     6. Hardware Diagnose                                          =
=     7. Reboot                                                     =
=                                                                   =
=====================================================================
Enter your choice:
```

*Figure B-1. Boot Manager Menu*

```
=====================================================================
=              (C) RAD Data Communication                           =
=                                                                   =
=        SERIAL SUBMENU         ( Version 1.02   )                  =
=                                                                   =
=     1. Download Application to System Zone                        =
=     2. Download Application to Backup Zone                        =
=     3. Update Bootrom                                             =
=     4. Exit to Main Menu                                          =
=                                                                   =
=====================================================================
Enter your choice:
```

*Figure B-2. Serial Submenu*

From the Boot Manager menu, you can:

- Download a new operating file (via XMODEM); the previous operating file will be saved as the backup file automatically.
- Restore system from backup zone
- Run hardware diagnostics
- Update Bootrom
- Erase backup zone or erase database
- Reset the IPmux-2L board

## B.2 Applications

New application software releases are distributed as separate files, which are downloaded to IPmux-2L using the XMODEM protocol from the Boot Manager menu. Alternatively, you can download a new software release via TFTP, XMODEM or YMODEM when the IPmux-2L application software is already running (**Main menu** > **File Utilities** > **Download/Upload by TFTP or Main menu** > **File Utilities** > **Download/Upload by xMODEM** ).

The TFTP protocol can also be used for uploading configuration files, which contain the IPmux-2L database to the management station. Administrators can use this capability to distribute verified configuration files to all other units, which use the similar configuration.

## Downloading Application Files via XMODEM

Downloading application files using the XMODEM protocol is performed from the Boot Manager menu.

➤ **To download application file via XMODEM:**

1. Configure your ASCII terminal or terminal emulation utility running on your PC to the 115.2 kbps data rate.
2. Access the Boot Manager menu.

   The Boot Manager menu appears (see *Figure B-1*), type **2**
3. From the Serial submenu:

   Select the system zone or backup zone by typing **1** or **2**.

   IPmux-2L responds with the following string:
   **`Please Select Program File.`**
4. Send the software release file to IPmux-2L using the XMODEM utility of you terminal application.
5. Once the downloading is completed and the file CRC check is OK, IPmux-2L saves the new release to the partition, and the boot sequence continues normally.

➤ **To update bootrom file:**

1. Configure your ASCII terminal or terminal emulation utility running on your PC to the 115.2 kbps data rate.
2. Access the Boot Manager menu.

   The Boot Manager menu appears (see *Figure B-1*), type **2**
3. From the Serial submenu:

   Select Update Bootrom by typing **3**.

   IPmux-2L responds with the following string:
   **`Please Select Program File.`**
4. Send the bootrom file to IPmux-2L using the XMODEM utility of you terminal application.

   IPmux-2L boots up automatically after the downloading is completed.

## Restoring the System from the Backup Zone

If the file in system zone is accidentally damaged or erased, the system can be recovered from the file in backup zone, but you should make sure the file in backup zone is OK.

➤ To restore system from backup zone:

1. Configure your ASCII terminal or terminal emulation utility running on your PC to the 115.2 kbps data rate.
2. Access the Boot Manager menu.

   The Boot Manager menu appears (see *Figure B-1*)
3. Restore system from backup zone:

   Select the Restore system from backup zone by typing **3**.

   IPmux-2L starts copying the file in backup zone to the system zone immediately.

## Erasing Backup Zone or Erasing Database

➤ To erase backup zone:

1. Configure your ASCII terminal or terminal emulation utility running on your PC to the 115.2 kbps data rate.
2. Access the Boot Manager menu.

   The Boot Manager menu appears (see *Figure B-1*)
3. Erase the backup zone:

   Select the Erase Backup Zone by typing **4**.

   **`Erase the application in backup zone, are you sure? (y/n)`**
4. Type **y** to start erasing the backup zone.

➤ To erase backup zone:

1. Configure your ASCII terminal or terminal emulation utility running on your PC to the 115.2 kbps data rate.
2. Access the Boot Manager menu.

   The Boot Manager menu appears (see *Figure B-1*)
3. Perform the Erase backup zone

   Select the Erase backup zone by typing **5**.

   **`Erase the database, are you sure? (y/n)`**
4. Type **y** to start erasing the database.

## Running the Hardware Diagnostics

➤ To perform the hardware diagnose:

1. Configure your ASCII terminal or terminal emulation utility running on your PC to the 115.2 kbps data rate.
2. Access the Boot Manager menu.

   The Boot Manager menu appears (see *Figure B-1*)

3. Perform the hardware diagnose:

   Select the Hardware diagnose by typing **6**.

   IPmux-2L starts the hardware diagnostic procedure.
   The results are displayed as follows:

```
=========================================================================
=              (C) RAD Data Communication                               =
=                                                                       =
=        Boot Menu         ( Version 1.02   )                          =
=                                                                       =
=     1. Boot Application from System Zone                              =
=     2. Boot from Serial Port                                          =
=     3. Restore System from Backup Zone and Run                        =
=     4. Erase Backup Zone                                              =
=     5. Erase Database                                                 =
=     6. Hardware Diagnose                                              =
=     7. Reboot                                                         =
=                                                                       =
=========================================================================
Enter your choice:6

PSRAM P/N: SST34HF32A4 (2M Bytes)

PSRAM Data Bus Test    : Passed

PSRAM Address Bus Test : Passed

PSRAM Device Test      : Passed

SDRAM Data Bus Test    : Passed

SDRAM Address Bus Test : Passed

SDRAM Device Test      : Passed

CPLD Access Test       : Passed

E2PROM Access Test     : Passed

LIU/FRAMER Access Test : Passed

RJ021 Access Test      : Passed
```

*Figure B-3. Hardware Diagnose Results*

# Appendix C

# SNMP Management

This appendix provides specific information for IPmux-2L management by SNMP (Simple Network Management Protocol).

The SNMP management functions of IPmux-2L are provided by an internal SNMP agent. The SNMP management communication uses UDP (User Datagram Protocol), which is a connectionless-mode transport protocol, part of the IP (Internet Protocol) protocol suite.

This appendix covers the information related to the SNMP environment.

## C.1 SNMP Environment

### SNMP Principles

The SNMP is an asynchronous command-response polling protocol. All management traffic is initiated by the SNMP-based network management station, which addresses the managed entities in its management domain. Only the addressed managed entity answers the polling of the management station (except for trap messages).

The managed entities include a function called an SNMP agent, which is responsible for interpretation and handling of the management station requests to the managed entity, and the generation of properly formatted responses to the management station.

### SNMP Operations

The SNMP protocol includes four types of operations:

- **getRequest**: Command for retrieving specific management information from the managed entity. The managed entity responds with a **getResponse** message.
- **getNextRequest**: Command for retrieving sequentially specific management information from the managed entity. The managed entity responds with a **getResponse** message.
- **setRequest**: Command for manipulating specific management information within the managed entity. The managed entity responds with a **getResponse** message.
- **trap**: Management message carrying unsolicited information on extraordinary events, which are events that occurred not in response to a management operation reported by the managed entity.

## Management Information Base (MIB)

The MIB includes a collection of managed objects. A managed object is defined as a parameter that can be managed, such as a performance statistics value. The MIB includes the definitions of relevant managed objects. Various MIBs can be defined for various management purposes or types of equipment.

An object definition includes the range of values (also called instances) and the following access rights:

- **Read-only**: Instances of that object can be read, but cannot be set.
- **Read-write**: Instances of that object can be read or set.
- **Write-only**: Instances of that object can be set, but cannot be read.
- **Not accessible**: Instances of that object cannot be read, or set.

## MIB Structure

The MIB has an inverted tree-like structure, with each definition of a managed object forming one leaf, located at the end of a branch of that tree.

Each leaf in the MIB is reached by a unique path. Thus, by numbering the branching points starting with the top, each leaf can be uniquely defined by a sequence of numbers.

The formal description of the managed objects and the MIB structure is provided in a special standardized format, called ASN.1 (Abstract Syntax Notation 1). Since the general collection of MIBs can also be organized in a similar structure, under IAB (Internet Activities Board) supervision, any parameter included in a MIB that is recognized by the IAB is uniquely defined.

To provide the flexibility necessary in a global structure, MIBs are classified in various classes (branches). One is the experimental branch and another the group of private (enterprise-specific) branch.

Under the private enterprise-specific branch of MIBs, each enterprise (manufacturer) can be assigned a number, which is its enterprise number. The assigned number designates the top of an enterprise-specific sub-tree of non-standard MIBs. Within this context, RAD has been assigned the enterprise number **164**. Therefore, enterprise MIBs published by RAD can be found under **1.3.6.1.4.1.164**.

MIBs of general interest are published by the IAB in the form of a Request for Comment (RFC) document. In addition, MIBs are also often assigned informal names that reflect their primary purpose. Enterprise-specific MIBs are published and distributed by their originator, who is responsible for their contents.

## MIBs Supported by the IPmux-2L SNMP Agent

The interpretation of the relevant MIBs is a function of the SNMP agent of each managed entity. The general MIBs supported by the IPmux-2L SNMP agent are:

- rfc1213.mib (except the interfaces view which is supported via RFC 2233)
- ianaiftype.mib (defines the ifType)

- rfc2233.mib (IF-MIB)
- rfc2011.mib
- rfc2012.mib
- rfc2013.mib
- rfc1907.mib
- rfc1215.mib
- rfc1493.mib
- rfc1643.mib
- rfc2239.mib
- rfc2494.mib
- rfc2261.mib
- rfc1695.mib
- rfc2674.mib
- rfc2819.mib
- rfc2495.mib (except Far End objects and RW configuration objects which are different for each configuration) - replaces RFC 1406; which is now obsolete.
- IPmux RAD private mib.

The IPmux-2L object ID is
**iso(1).org(3).dod(6).internet(1).private(4).enterprises(1).rad(164).radGen(6).systems(1).radSysWan(3). Ipmux-2L (145)**

Enterprise-specific MIBs supported by RAD equipment, including other members of the IPmux family, are available in ASN.1 format from the RAD Technical Support department.

## Management Domains under SNMP

In principle, SNMP allows each management station that recognizes the MIBs supported by a device to perform all the management operations available on that device. However, this is not desirable in actual practice, it is necessary to provide a means to delimit management domains.

## SNMP Communities

SNMP delimits management domains by defining communities. Each community is identified by a name, which is an alphanumeric string of up to 255 characters defined by the user.

The IPmux-2L SNMP agent defines strings of up to 10 characters (case sensitive, numeric and alphabetical).

Any SNMP entity (both managed entities and management stations) is assigned a community name by its user. In parallel, the user defines a list of the communities for each SNMP entity that are authorized to communicate with the entity, and the access rights associated with each community (this is the SNMP community name table of the entity).

In general, SNMP agents support two types of access rights:

**Read-Only**: The SNMP agent accepts and processes only SNMP **getRequest** and **getNextRequest** commands from management stations which have a Read-Only community name.

**Read-Write**: The SNMP agent accepts and processes all the SNMP commands received from a management station with a Read-Write community name.

## Authentication

In accordance with SNMP protocol, the SNMP community of the originating entity is sent in each message.

When an SNMP message is received by the addressed entity, it first checks the originator's community. Messages with community names not included in the SNMP community names table of the recipient are discarded. SNMP agents of managed entities usually report this event by means of an authentication failure trap.

The SNMP agents of managed entities evaluate messages originated by communities appearing in the agent's SNMP community names table in accordance with the access rights, as previously explained. Thus, a **setRequest** for a MIB object with read-write access rights will nevertheless be rejected if it comes from a management station whose community has read-only rights with respect to that particular agent.

## Network Management Stations

The IPmux-2L SNMP agent stores the IP address of the Network Management Station (NMS) that is intended to manage it.

Supplement

# AC/DC Adapter (AD) Plug

## for DC Power Supply Connection

***Note*** *Ignore this supplement if the unit is AC-powered.*

Certain units are equipped with a wide-range AC/DC power supply. These units are equipped with a standard AC-type 3-prong power input connector located on the unit rear panel. This power input connector can be used for both AC and DC voltage inputs.

For DC operation, a compatible straight or 90-degree AC/DC Adapter (AD) plug for attaching to your DC power supply cable is supplied with your RAD product (see *Figure 1* and *Figure 2*).

Connect the wires of your DC power supply cable to the AD plug, according to the voltage polarity and assembly instructions provided on *page 2*.

*Figure 1. Straight AD Plug*

*Figure 2. 90-Degree AD Plug*

***Caution***

Prepare all connections to the AD plug **before** inserting it into the unit's power connector.

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➤ **To prepare the AD plug and connect it to the DC power supply cable:**

1. Loosen the cover screw on the bottom of the AD plug to open it (see *Figure 3*).
2. Run your DC power supply cable through the removable cable guard and through the open cable clamp.
3. Place each DC wire lead into the appropriate AD plug wire terminal according to the voltage polarity mapping shown. Afterwards, tighten the terminal screws closely.
4. Fit the cable guard in its slot and then close the clamp over the cable. Tighten the clamp screws to secure the cable.
5. Reassemble the two halves of the AD plug and tighten the cover screw.
6. Connect the assembled power supply cable to the unit.

***Note**: You have to flip over the non-90-degree AD plug type by 180 degrees to insert it into the unit. After inserting it, verify that the blue (negative) wire is connected to the POWER and the brown (positive) wire is connected to the RETURN.*

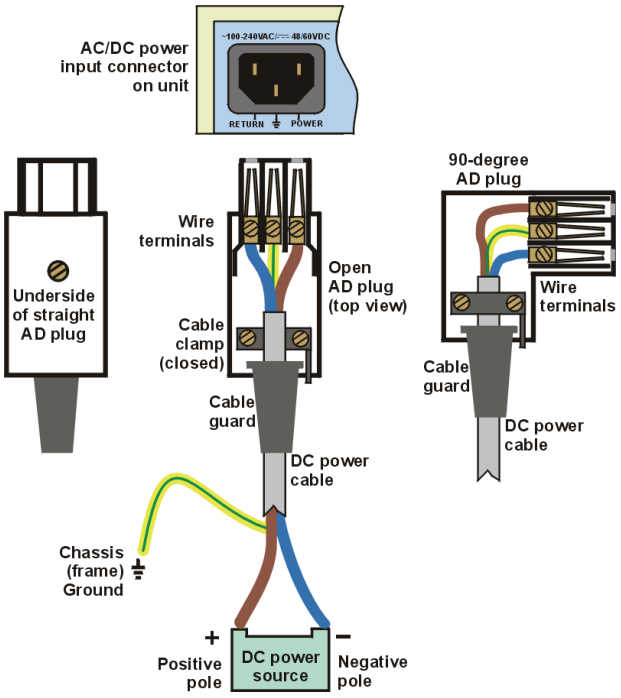


*Figure 3. AD Plug Details*

***Warning***

- **Reversing the wire voltage polarity will not cause damage to the unit, but the internal protection fuse will not function.**
- **Always connect a ground wire to the AD plug's chassis (frame) ground terminal. Connecting the unit without a protective ground, or interrupting the grounding (for example, by using an extension power cord without a grounding conductor) can damage the unit or the equipment connected to it!**
- **The AD adapter is not intended for field wiring.**

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**Publication Number:** 517-200-12/08

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